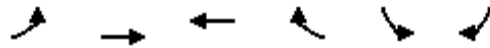


Appendix D
Capacity Analysis

HCM Unsignalized Intersection Capacity Analysis
 1: Concord Ave & Rte 2 EB Ramp

2009 Existing AM



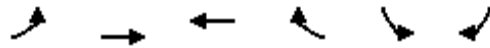
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↔	↔			↔
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	198	176	116	0	0	329
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	215	191	126	0	0	358
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	126				748	126
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	126				748	126
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	85				100	61
cM capacity (veh/h)	1460				324	924

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	407	126	358
Volume Left	215	0	0
Volume Right	0	0	358
cSH	1460	1700	924
Volume to Capacity	0.15	0.07	0.39
Queue Length 95th (ft)	13	0	46
Control Delay (s)	4.8	0.0	11.3
Lane LOS	A		B
Approach Delay (s)	4.8	0.0	11.3
Approach LOS			B

Intersection Summary			
Average Delay		6.7	
Intersection Capacity Utilization	33.1%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
 1: Concord Ave & Rte 2 EB Ramp

2014 No Build AM



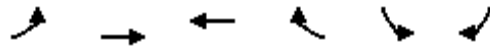
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↶	↷			↷
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	215	198	205	5	0	653
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	234	215	223	5	0	710
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	228				908	226
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	228				908	226
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	83				100	13
cM capacity (veh/h)	1340				252	814

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	449	228	710
Volume Left	234	0	0
Volume Right	0	5	710
cSH	1340	1700	814
Volume to Capacity	0.17	0.13	0.87
Queue Length 95th (ft)	16	0	276
Control Delay (s)	5.1	0.0	31.3
Lane LOS	A		D
Approach Delay (s)	5.1	0.0	31.3
Approach LOS			D

Intersection Summary			
Average Delay		17.7	
Intersection Capacity Utilization	58.2%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
 1: Concord Ave & Rte 2 EB Ramp

2014 Build AM



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↶	↷			↷
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	234	199	208	5	0	765
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	254	216	226	5	0	832
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	232				954	229
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	232				954	229
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	81				100	0
cM capacity (veh/h)	1336				232	810

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	471	232	832
Volume Left	254	0	0
Volume Right	0	5	832
cSH	1336	1700	810
Volume to Capacity	0.19	0.14	1.03
Queue Length 95th (ft)	18	0	476
Control Delay (s)	5.3	0.0	61.0
Lane LOS	A		F
Approach Delay (s)	5.3	0.0	61.0
Approach LOS			F

Intersection Summary			
Average Delay		34.7	
Intersection Capacity Utilization	65.3%	ICU Level of Service	C
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
2: Concord Ave & Spring Street

2009 Existing AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↶	↷	↷		↶	↷
Sign Control	Stop		Free		Free	Free
Grade	2%		0%			-2%
Volume (veh/h)	167	278	125	115	259	668
Peak Hour Factor	0.90	0.90	0.77	0.77	0.94	0.94
Hourly flow rate (vph)	186	309	162	149	276	711
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	Raised					
Median storage (veh)	0					
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1499	237			312	
vC1, stage 1 conf vol	237					
vC2, stage 2 conf vol	1262					
vCu, unblocked vol	1499	237			312	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	61			78	
cM capacity (veh/h)	132	802			1249	
Direction, Lane #	WB 1	WB 2	NB 1	SB 1	SB 2	
Volume Total	186	309	312	276	711	
Volume Left	186	0	0	276	0	
Volume Right	0	309	149	0	0	
cSH	132	802	1700	1249	1700	
Volume to Capacity	1.41	0.39	0.18	0.22	0.42	
Queue Length 95th (ft)	308	46	0	21	0	
Control Delay (s)	283.3	12.3	0.0	8.7	0.0	
Lane LOS	F	B		A		
Approach Delay (s)	114.0		0.0	2.4		
Approach LOS	F					
Intersection Summary						
Average Delay			32.8			
Intersection Capacity Utilization			51.1%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
2: Concord Ave & Spring Street

2014 No Build AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↶	↷	↷		↶	↷
Sign Control	Stop		Free		Free	Free
Grade	2%		0%			-2%
Volume (veh/h)	176	682	194	121	292	711
Peak Hour Factor	0.90	0.90	0.77	0.77	0.94	0.94
Hourly flow rate (vph)	196	758	252	157	311	756
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	Raised					
Median storage (veh)	0					
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1708	331			409	
vC1, stage 1 conf vol	331					
vC2, stage 2 conf vol	1378					
vCu, unblocked vol	1708	331			409	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	0			73	
cM capacity (veh/h)	107	711			1150	
Direction, Lane #	WB 1	WB 2	NB 1	SB 1	SB 2	
Volume Total	196	758	409	311	756	
Volume Left	196	0	0	311	0	
Volume Right	0	758	157	0	0	
cSH	107	711	1700	1150	1700	
Volume to Capacity	1.82	1.07	0.24	0.27	0.44	
Queue Length 95th (ft)	392	501	0	27	0	
Control Delay (s)	471.8	76.4	0.0	9.3	0.0	
Lane LOS	F	F		A		
Approach Delay (s)	157.5		0.0	2.7		
Approach LOS	F					
Intersection Summary						
Average Delay			63.0			
Intersection Capacity Utilization			66.5%		ICU Level of Service	C
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
2: Concord Ave & Spring Street






















2014 Build AM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↶	↷	↷		↶	↷
Sign Control	Stop		Free		Free	Free
Grade	2%		0%			-2%
Volume (veh/h)	176	797	206	121	312	714
Peak Hour Factor	0.90	0.90	0.77	0.77	0.94	0.94
Hourly flow rate (vph)	196	886	268	157	332	760
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	Raised					
Median storage (veh)	0					
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1770	346			425	
vC1, stage 1 conf vol	346					
vC2, stage 2 conf vol	1423					
vCu, unblocked vol	1770	346			425	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	0			71	
cM capacity (veh/h)	99	697			1135	
Direction, Lane #	WB 1	WB 2	NB 1	SB 1	SB 2	
Volume Total	196	886	425	332	760	
Volume Left	196	0	0	332	0	
Volume Right	0	886	157	0	0	
cSH	99	697	1700	1135	1700	
Volume to Capacity	1.98	1.27	0.25	0.29	0.45	
Queue Length 95th (ft)	413	838	0	31	0	
Control Delay (s)	544.7	152.8	0.0	9.5	0.0	
Lane LOS	F	F		A		
Approach Delay (s)	223.7		0.0	2.9		
Approach LOS	F					
Intersection Summary						
Average Delay			94.3			
Intersection Capacity Utilization			74.2%		ICU Level of Service	D
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 3: Patriot Way & Spring Street

2009 Existing AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control	Stop			Stop				Free			Free	
Grade	0%			0%				0%			-2%	
Volume (veh/h)	10	7	7	172	14	58	45	157	220	102	723	13
Peak Hour Factor	0.60	0.60	0.60	0.91	0.91	0.91	0.87	0.87	0.87	0.88	0.88	0.88
Hourly flow rate (vph)	17	12	12	189	15	64	52	180	253	116	822	15
Pedestrians	6			4				1				
Lane Width (ft)	12.0			13.0				12.0				
Walking Speed (ft/s)	4.0			4.0				4.0				
Percent Blockage	0			0				0				
Right turn flare (veh)												
Median type	Raised			Raised								
Median storage veh	0			0								
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1422	1608	836	1486	1489	311	842			437		
vC1, stage 1 conf vol	1067	1067		414	414							
vC2, stage 2 conf vol	355	541		1072	1074							
vCu, unblocked vol	1422	1608	836	1486	1489	311	842			437		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)	6.1	5.5		6.1	5.5							
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	87	91	97	0	88	91	93			90		
cM capacity (veh/h)	130	134	365	106	130	727	789			1118		
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2			
Volume Total	17	23	189	15	64	52	433	116	836			
Volume Left	17	0	189	0	0	52	0	116	0			
Volume Right	0	12	0	0	64	0	253	0	15			
cSH	130	196	106	130	727	789	1700	1118	1700			
Volume to Capacity	0.13	0.12	1.78	0.12	0.09	0.07	0.25	0.10	0.49			
Queue Length 95th (ft)	11	10	377	10	7	5	0	9	0			
Control Delay (s)	36.8	25.9	456.5	36.4	10.4	9.9	0.0	8.6	0.0			
Lane LOS	E	D	F	E	B	A		A				
Approach Delay (s)	30.4		326.4			1.1		1.0				
Approach LOS	D		F									
Intersection Summary												
Average Delay			51.7									
Intersection Capacity Utilization			68.4%		ICU Level of Service				C			
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
 3: Patriot Way & Spring Street

2014 No Build AM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations													
Sign Control	Stop		Stop		Free		Free						
Grade	0%		0%		0%		-2%						
Volume (veh/h)	33	44	30	183	130	62	380	195	320	123	760	207	
Peak Hour Factor	0.92	0.92	0.92	0.91	0.91	0.91	0.87	0.87	0.87	0.88	0.88	0.88	
Hourly flow rate (vph)	36	48	33	201	143	68	437	224	368	140	864	235	
Pedestrians	6		4		1								
Lane Width (ft)	12.0		12.0		12.0								
Walking Speed (ft/s)	4.0		4.0		4.0								
Percent Blockage	0		0		0								
Right turn flare (veh)													
Median type	Raised		Raised										
Median storage (veh)	0		0										
Upstream signal (ft)													
pX, platoon unblocked													
vC, conflicting volume	2504	2736	988	2486	2670	412	1105			596			
vC1, stage 1 conf vol	1267	1267		1286	1286								
vC2, stage 2 conf vol	1237	1470		1201	1384								
vCu, unblocked vol	2504	2736	988	2486	2670	412	1105			596			
tC, single (s)	7.4	6.8	6.5	7.1	6.5	6.2	4.1			4.1			
tC, 2 stage (s)	6.4	5.8		6.1	5.5								
tF (s)	3.8	4.3	3.6	3.5	4.0	3.3	2.2			2.2			
p0 queue free %	0	0	88	0	0	89	30			86			
cM capacity (veh/h)	0	4	265	0	6	640	625			982			
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2				
Volume Total	36	80	201	143	68	437	592	140	1099				
Volume Left	36	0	201	0	0	437	0	140	0				
Volume Right	0	33	0	0	68	0	368	0	235				
cSH	0	7	0	6	640	625	1700	982	1700				
Volume to Capacity	Err	11.55	Err	24.77	0.11	0.70	0.35	0.14	0.65				
Queue Length 95th (ft)	Err	Err	Err	Err	9	140	0	12	0				
Control Delay (s)	Err	Err	Err	Err	11.3	23.0	0.0	9.3	0.0				
Lane LOS	F	F	F	F	B	C		A					
Approach Delay (s)	Err		Err		9.8			1.0					
Approach LOS	F		F										
Intersection Summary													
Average Delay			Err										
Intersection Capacity Utilization			101.7%		ICU Level of Service						G		
Analysis Period (min)			15										

HCM Unsignalized Intersection Capacity Analysis
3: Patriot Way & Spring Street

2014 Build AM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control	Stop		Stop		Free		Free					
Grade	0%		0%		0%		-2%					
Volume (veh/h)	45	85	53	183	260	62	507	195	320	123	760	270
Peak Hour Factor	0.92	0.92	0.92	0.91	0.91	0.91	0.87	0.87	0.87	0.88	0.88	0.88
Hourly flow rate (vph)	49	92	58	201	286	68	583	224	368	140	864	307
Pedestrians	6		4		1							
Lane Width (ft)	12.0		12.0		12.0							
Walking Speed (ft/s)	4.0		4.0		4.0							
Percent Blockage	0		0		0							
Right turn flare (veh)												
Median type	Raised		Raised									
Median storage (veh)	0		0									
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2903	3064	1024	2826	3034	412	1176			596		
vC1, stage 1 conf vol	1303	1303		1578	1578							
vC2, stage 2 conf vol	1601	1761		1248	1456							
vCu, unblocked vol	2903	3064	1024	2826	3034	412	1176			596		
tC, single (s)	7.4	6.8	6.5	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)	6.4	5.8		6.1	5.5							
tF (s)	3.8	4.3	3.6	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	77	0	0	89	1			86		
cM capacity (veh/h)	0	0	252	0	0	640	587			982		
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2			
Volume Total	49	150	201	286	68	583	592	140	1170			
Volume Left	49	0	201	0	0	583	0	140	0			
Volume Right	0	58	0	0	68	0	368	0	307			
cSH	0	0	0	0	640	587	1700	982	1700			
Volume to Capacity	Err	493.18	Err	450.46	0.11	0.99	0.35	0.14	0.69			
Queue Length 95th (ft)	Err	Err	Err	Err	9	363	0	12	0			
Control Delay (s)	Err	Err	Err	Err	11.3	61.8	0.0	9.3	0.0			
Lane LOS	F	F	F	F	B	F		A				
Approach Delay (s)	Err		Err		30.7		1.0					
Approach LOS	F		F									
Intersection Summary												
Average Delay			Err									
Intersection Capacity Utilization	116.1%		ICU Level of Service		H							
Analysis Period (min)	15											

HCM Unsignalized Intersection Capacity Analysis
4: Shade Street & Spring Street

2009 Existing AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	W			T	T	
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	5	57	27	176	815	4
Peak Hour Factor	0.90	0.90	0.74	0.74	0.79	0.79
Hourly flow rate (vph)	6	63	36	238	1032	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1345	1034	1037			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1345	1034	1037			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	96	78	95			
cM capacity (veh/h)	158	282	671			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	69	274	1037			
Volume Left	6	36	0			
Volume Right	63	0	5			
cSH	265	671	1700			
Volume to Capacity	0.26	0.05	0.61			
Queue Length 95th (ft)	25	4	0			
Control Delay (s)	23.3	2.0	0.0			
Lane LOS	C	A				
Approach Delay (s)	23.3	2.0	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay			1.6			
Intersection Capacity Utilization		53.6%		ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 4: Shade Street & Spring Street

2014 No Build AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	6	60	29	187	1111	5
Peak Hour Factor	0.74	0.74	0.79	0.79	0.90	0.90
Hourly flow rate (vph)	8	81	37	237	1234	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1547	1237	1240			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1547	1237	1240			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	93	62	93			
cM capacity (veh/h)	117	214	562			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	89	273	1240			
Volume Left	8	37	0			
Volume Right	81	0	6			
cSH	200	562	1700			
Volume to Capacity	0.45	0.07	0.73			
Queue Length 95th (ft)	53	5	0			
Control Delay (s)	36.9	2.4	0.0			
Lane LOS	E	A				
Approach Delay (s)	36.9	2.4	0.0			
Approach LOS	E					
Intersection Summary						
Average Delay			2.5			
Intersection Capacity Utilization		69.5%		ICU Level of Service		C
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
4: Shade Street & Spring Street

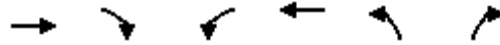
2014 Build AM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	↔			↑	↑	
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	6	60	29	199	1174	5
Peak Hour Factor	0.74	0.74	0.79	0.79	0.90	0.90
Hourly flow rate (vph)	8	81	37	252	1304	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1633	1307	1310			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1633	1307	1310			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	92	58	93			
cM capacity (veh/h)	104	195	528			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	89	289	1310			
Volume Left	8	37	0			
Volume Right	81	0	6			
cSH	181	528	1700			
Volume to Capacity	0.49	0.07	0.77			
Queue Length 95th (ft)	60	6	0			
Control Delay (s)	43.0	2.4	0.0			
Lane LOS	E	A				
Approach Delay (s)	43.0	2.4	0.0			
Approach LOS	E					
Intersection Summary						
Average Delay			2.7			
Intersection Capacity Utilization			72.8%	ICU Level of Service	C	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 5: Marrett Rd (Rte 2A) & Spring Street

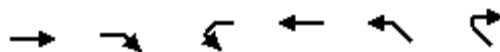
2009 Existing AM



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↻			↻	↻	↻
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	273	452	394	406	98	111
Peak Hour Factor	0.91	0.91	0.94	0.94	0.89	0.89
Hourly flow rate (vph)	300	497	419	432	110	125
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			797		1819	548
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			797		1819	548
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			49		0	77
cM capacity (veh/h)			825		42	536

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	797	851	235
Volume Left	0	419	110
Volume Right	497	0	125
cSH	1700	825	82
Volume to Capacity	0.47	0.51	2.85
Queue Length 95th (ft)	0	73	573
Control Delay (s)	0.0	11.5	944.4
Lane LOS		B	F
Approach Delay (s)	0.0	11.5	944.4
Approach LOS			F

Intersection Summary			
Average Delay		123.0	
Intersection Capacity Utilization	107.5%		ICU Level of Service G
Analysis Period (min)		15	



Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations	↑			↑	↘	↘
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	384	0	0	772	28	23
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	384	0	0	772	28	23
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			384	1156	384	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			384	1156	384	
tC, single (s)			4.1	6.4	6.2	
tC, 2 stage (s)						
tF (s)			2.2	3.5	3.3	
p0 queue free %			100	87	97	
cM capacity (veh/h)			1174	217	664	
Direction, Lane #	EB 1	WB 1	NW 1			
Volume Total	384	772	51			
Volume Left	0	0	28			
Volume Right	0	0	23			
cSH	1700	1700	312			
Volume to Capacity	0.23	0.45	0.16			
Queue Length 95th (ft)	0	0	14			
Control Delay (s)	0.0	0.0	18.8			
Lane LOS			C			
Approach Delay (s)	0.0	0.0	18.8			
Approach LOS			C			
Intersection Summary						
Average Delay			0.8			
Intersection Capacity Utilization		50.6%		ICU Level of Service		A
Analysis Period (min)			15			

Timings
5: Marrett Rd (Rte 2A) & Spring Street

2014 No Build AM



Lane Group	EBT	WBL	WBT	NBL	ø9
Lane Configurations	↻	↻	↻	↻	
Volume (vph)	287	536	428	148	
Lane Group Flow (vph)	983	570	455	327	
Turn Type	pm+pt				
Protected Phases	4	3	8	2	9
Permitted Phases	8				
Detector Phases	4	3	8	2	
Minimum Initial (s)	4.0	4.0	4.0	4.0	2.0
Minimum Split (s)	22.0	10.0	22.0	22.0	15.0
Total Split (s)	60.0	30.0	90.0	25.0	21.0
Total Split (%)	44.1%	22.1%	66.2%	18.4%	15%
Yellow Time (s)	4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	2.0	2.0	2.0	2.0	0.0
Lead/Lag	Lag	Lead			
Lead-Lag Optimize?	Yes				
Recall Mode	None	None	None	Min	None
v/c Ratio	1.19	1.27	0.34	1.00	
Control Delay	125.6	170.6	7.1	93.3	
Queue Delay	0.0	0.0	0.0	0.0	
Total Delay	125.6	170.6	7.1	93.3	
Queue Length 50th (ft)	~831	~477	97	222	
Queue Length 95th (ft)	#1276	#825	221	#480	
Internal Link Dist (ft)	2551		834	1808	
Turn Bay Length (ft)	150				
Base Capacity (vph)	825	448	1344	328	
Starvation Cap Reductn	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	
Storage Cap Reductn	0	0	0	0	
Reduced v/c Ratio	1.19	1.27	0.34	1.00	

Intersection Summary

Cycle Length: 136

Actuated Cycle Length: 118

Natural Cycle: 150

Control Type: Actuated-Uncoordinated

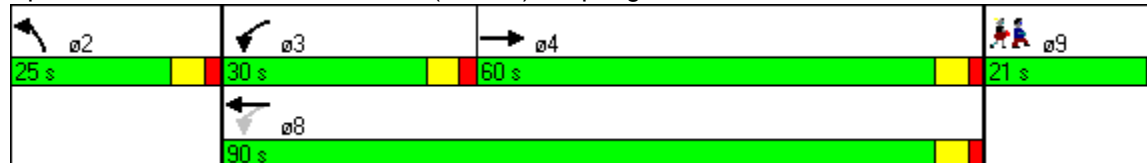
~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

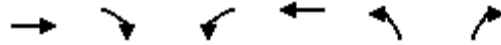
Queue shown is maximum after two cycles.

Splits and Phases: 5: Marrett Rd (Rte 2A) & Spring Street



HCM Signalized Intersection Capacity Analysis
 5: Marrett Rd (Rte 2A) & Spring Street

2014 No Build AM



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↩		↩	↩	↩	↩
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0	4.0	
Lane Util. Factor	1.00		1.00	1.00	1.00	
Frbp, ped/bikes	0.98		1.00	1.00	1.00	
Flpb, ped/bikes	1.00		1.00	1.00	1.00	
Frt	0.91		1.00	1.00	0.93	
Flt Protected	1.00		0.95	1.00	0.98	
Satd. Flow (prot)	1630		1748	1840	1693	
Flt Permitted	1.00		0.07	1.00	0.98	
Satd. Flow (perm)	1630		122	1840	1693	
Volume (vph)	287	608	536	428	148	153
Peak-hour factor, PHF	0.91	0.91	0.94	0.94	0.92	0.92
Adj. Flow (vph)	315	668	570	455	161	166
RTOR Reduction (vph)	50	0	0	0	26	0
Lane Group Flow (vph)	933	0	570	455	301	0
Confl. Peds. (#/hr)		2	2			
Heavy Vehicles (%)	3%	3%	2%	2%	2%	2%
Bus Blockages (#/hr)	3	3	3	3	0	0
Turn Type			pm+pt			
Protected Phases	4		3	8	2	
Permitted Phases			8			
Actuated Green, G (s)	54.1		84.2	84.2	19.0	
Effective Green, g (s)	56.1		86.2	86.2	21.0	
Actuated g/C Ratio	0.47		0.72	0.72	0.18	
Clearance Time (s)	6.0		6.0	6.0	6.0	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)	765		443	1326	297	
v/s Ratio Prot	0.57		c0.28	0.25	c0.18	
v/s Ratio Perm			c0.64			
v/c Ratio	1.22		1.29	0.34	1.01	
Uniform Delay, d1	31.8		49.0	6.2	49.3	
Progression Factor	1.00		1.00	1.00	1.00	
Incremental Delay, d2	110.3		145.2	0.2	55.4	
Delay (s)	142.0		194.2	6.4	104.7	
Level of Service	F		F	A	F	
Approach Delay (s)	142.0			110.8	104.7	
Approach LOS	F			F	F	

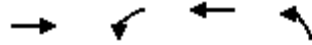
Intersection Summary

HCM Average Control Delay	123.1	HCM Level of Service	F
HCM Volume to Capacity ratio	1.22		
Actuated Cycle Length (s)	119.6	Sum of lost time (s)	12.4
Intersection Capacity Utilization	109.9%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Timings
5: Marrett Rd (Rte 2A) & Spring Street

2014 Build AM



Lane Group	EBT	WBL	WBT	NBL	ø9
Lane Configurations	↻	↻	↻	↻	
Volume (vph)	287	569	428	156	
Lane Group Flow (vph)	1018	605	455	341	
Turn Type	pm+pt				
Protected Phases	4	3	8	2	9
Permitted Phases	8				
Detector Phases	4	3	8	2	
Minimum Initial (s)	4.0	4.0	4.0	4.0	2.0
Minimum Split (s)	22.0	10.0	22.0	22.0	15.0
Total Split (s)	60.0	30.0	90.0	25.0	21.0
Total Split (%)	44.1%	22.1%	66.2%	18.4%	15%
Yellow Time (s)	4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	2.0	2.0	2.0	2.0	0.0
Lead/Lag	Lag	Lead			
Lead-Lag Optimize?	Yes				
Recall Mode	None	None	None	Min	None
v/c Ratio	1.23	1.35	0.34	1.04	
Control Delay	141.6	202.3	7.1	103.7	
Queue Delay	0.0	0.0	0.0	0.0	
Total Delay	141.6	202.3	7.1	103.7	
Queue Length 50th (ft)	~883	~532	97	~248	
Queue Length 95th (ft)	#1336	#891	221	#508	
Internal Link Dist (ft)	2551		834	1808	
Turn Bay Length (ft)	150				
Base Capacity (vph)	827	448	1344	328	
Starvation Cap Reductn	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	
Storage Cap Reductn	0	0	0	0	
Reduced v/c Ratio	1.23	1.35	0.34	1.04	

Intersection Summary

Cycle Length: 136

Actuated Cycle Length: 118

Natural Cycle: 150

Control Type: Actuated-Uncoordinated

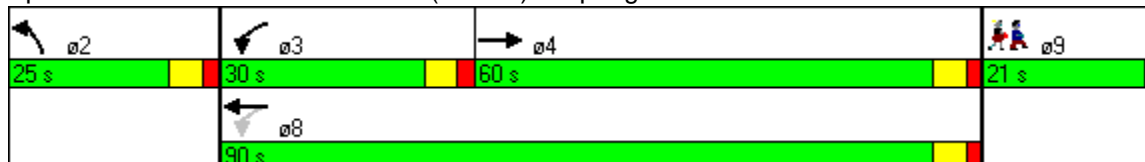
~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

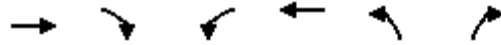
Queue shown is maximum after two cycles.

Splits and Phases: 5: Marrett Rd (Rte 2A) & Spring Street



HCM Signalized Intersection Capacity Analysis
 5: Marrett Rd (Rte 2A) & Spring Street

2014 Build AM



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↩		↩	↩	↩	↩
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0	4.0	
Lane Util. Factor	1.00		1.00	1.00	1.00	
Frbp, ped/bikes	0.98		1.00	1.00	1.00	
Flpb, ped/bikes	1.00		1.00	1.00	1.00	
Frt	0.91		1.00	1.00	0.93	
Flt Protected	1.00		0.95	1.00	0.98	
Satd. Flow (prot)	1627		1748	1840	1694	
Flt Permitted	1.00		0.07	1.00	0.98	
Satd. Flow (perm)	1627		122	1840	1694	
Volume (vph)	287	640	569	428	156	157
Peak-hour factor, PHF	0.91	0.91	0.94	0.94	0.92	0.92
Adj. Flow (vph)	315	703	605	455	170	171
RTOR Reduction (vph)	53	0	0	0	26	0
Lane Group Flow (vph)	965	0	605	455	315	0
Confl. Peds. (#/hr)		2	2			
Heavy Vehicles (%)	3%	3%	2%	2%	2%	2%
Bus Blockages (#/hr)	3	3	3	3	0	0
Turn Type			pm+pt			
Protected Phases	4		3	8	2	
Permitted Phases			8			
Actuated Green, G (s)	54.1		84.2	84.2	19.0	
Effective Green, g (s)	56.1		86.2	86.2	21.0	
Actuated g/C Ratio	0.47		0.72	0.72	0.18	
Clearance Time (s)	6.0		6.0	6.0	6.0	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)	763		443	1326	297	
v/s Ratio Prot	0.59		c0.30	0.25	c0.19	
v/s Ratio Perm			c0.68			
v/c Ratio	1.26		1.37	0.34	1.06	
Uniform Delay, d1	31.8		49.0	6.2	49.3	
Progression Factor	1.00		1.00	1.00	1.00	
Incremental Delay, d2	129.5		178.5	0.2	69.6	
Delay (s)	161.2		227.5	6.4	118.9	
Level of Service	F		F	A	F	
Approach Delay (s)	161.2			132.6	118.9	
Approach LOS	F			F	F	











Intersection Summary

HCM Average Control Delay	142.7	HCM Level of Service	F
HCM Volume to Capacity ratio	1.29		
Actuated Cycle Length (s)	119.6	Sum of lost time (s)	12.4
Intersection Capacity Utilization	114.4%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group











HCM Unsignalized Intersection Capacity Analysis
 7: Middle Street & Marrett Rd (Rte 2A)

2009 Existing AM

						
Movement	NBL	NBR	SET	SER	NWL	NWT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	39	28	656	30	0	434
Peak Hour Factor	0.57	0.57	0.94	0.93	0.85	0.85
Hourly flow rate (vph)	68	49	698	32	0	511
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1225	714			730	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1225	714			730	
tC, single (s)	6.5	7.2			4.1	
tC, 2 stage (s)						
tF (s)	3.6	4.2			2.2	
p0 queue free %	64	84			100	
cM capacity (veh/h)	190	303			865	
Direction, Lane #	NB 1	NB 2	SE 1	NW 1		
Volume Total	68	49	730	511		
Volume Left	68	0	0	0		
Volume Right	0	49	32	0		
cSH	190	303	1700	1700		
Volume to Capacity	0.36	0.16	0.43	0.30		
Queue Length 95th (ft)	38	14	0	0		
Control Delay (s)	34.2	19.2	0.0	0.0		
Lane LOS	D	C				
Approach Delay (s)	27.9		0.0	0.0		
Approach LOS	D					
Intersection Summary						
Average Delay			2.4			
Intersection Capacity Utilization			46.3%		ICU Level of Service	A
Analysis Period (min)			15			











HCM Unsignalized Intersection Capacity Analysis
7: Middle Street & Marrett Rd (Rte 2A)

2014 No Build AM

						
Movement	NBL	NBR	SET	SER	NWL	NWT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	39	28	786	30	0	474
Peak Hour Factor	0.57	0.57	0.94	0.93	0.85	0.85
Hourly flow rate (vph)	68	49	836	32	0	558
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1410	852			868	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1410	852			868	
tC, single (s)	6.5	7.2			4.1	
tC, 2 stage (s)						
tF (s)	3.6	4.2			2.2	
p0 queue free %	53	80			100	
cM capacity (veh/h)	146	246			767	
Direction, Lane #	NB 1	NB 2	SE 1	NW 1		
Volume Total	68	49	868	558		
Volume Left	68	0	0	0		
Volume Right	0	49	32	0		
cSH	146	246	1700	1700		
Volume to Capacity	0.47	0.20	0.51	0.33		
Queue Length 95th (ft)	54	18	0	0		
Control Delay (s)	49.5	23.2	0.0	0.0		
Lane LOS	E	C				
Approach Delay (s)	38.5		0.0	0.0		
Approach LOS	E					
Intersection Summary						
Average Delay			2.9			
Intersection Capacity Utilization			53.2%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 7: Middle Street & Marrett Rd (Rte 2A)

2014 Build AM

						
Movement	NBL	NBR	SET	SER	NWL	NWT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	39	28	819	30	0	482
Peak Hour Factor	0.57	0.57	0.94	0.93	0.85	0.85
Hourly flow rate (vph)	68	49	871	32	0	567
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1454	887			904	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1454	887			904	
tC, single (s)	6.5	7.2			4.1	
tC, 2 stage (s)						
tF (s)	3.6	4.2			2.2	
p0 queue free %	50	79			100	
cM capacity (veh/h)	137	233			744	
Direction, Lane #	NB 1	NB 2	SE 1	NW 1		
Volume Total	68	49	904	567		
Volume Left	68	0	0	0		
Volume Right	0	49	32	0		
cSH	137	233	1700	1700		
Volume to Capacity	0.50	0.21	0.53	0.33		
Queue Length 95th (ft)	58	19	0	0		
Control Delay (s)	54.7	24.5	0.0	0.0		
Lane LOS	F	C				
Approach Delay (s)	42.1		0.0	0.0		
Approach LOS	E					
Intersection Summary						
Average Delay			3.1			
Intersection Capacity Utilization			54.9%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
8: Hayden Ave & Rte 2 WB On-Ramp

2009 Existing AM

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗		↖		
Sign Control	Free			Free	Stop	
Grade	-2%			2%	0%	
Volume (veh/h)	208	67	168	320	0	0
Peak Hour Factor	0.88	0.88	0.90	0.90	1.00	1.00
Hourly flow rate (vph)	236	76	187	356	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			312		965	236
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			312		965	236
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			85		100	100
cM capacity (veh/h)			1248		240	803
Direction, Lane #	EB 1	EB 2	WB 1			
Volume Total	236	76	542			
Volume Left	0	0	187			
Volume Right	0	76	0			
cSH	1700	1700	1248			
Volume to Capacity	0.14	0.04	0.15			
Queue Length 95th (ft)	0	0	13			
Control Delay (s)	0.0	0.0	3.9			
Lane LOS			A			
Approach Delay (s)	0.0		3.9			
Approach LOS						
Intersection Summary						
Average Delay			2.5			
Intersection Capacity Utilization			43.7%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 8: Hayden Ave & Rte 2 WB On-Ramp

2014 No Build AM

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗		↖		
Sign Control	Free			Free	Stop	
Grade	-2%			2%	0%	
Volume (veh/h)	230	115	177	570	0	0
Peak Hour Factor	0.88	0.88	0.90	0.90	1.00	1.00
Hourly flow rate (vph)	261	131	197	633	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			392	1288	261	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			392	1288	261	
tC, single (s)			4.1	6.4	6.2	
tC, 2 stage (s)						
tF (s)			2.2	3.5	3.3	
p0 queue free %			83	100	100	
cM capacity (veh/h)			1166	150	777	
Direction, Lane #	EB 1	EB 2	WB 1			
Volume Total	261	131	830			
Volume Left	0	0	197			
Volume Right	0	131	0			
cSH	1700	1700	1166			
Volume to Capacity	0.15	0.08	0.17			
Queue Length 95th (ft)	0	0	15			
Control Delay (s)	0.0	0.0	3.9			
Lane LOS			A			
Approach Delay (s)	0.0		3.9			
Approach LOS						
Intersection Summary						
Average Delay			2.6			
Intersection Capacity Utilization			58.6%	ICU Level of Service		B
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 8: Hayden Ave & Rte 2 WB On-Ramp

2014 Build AM

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗		↖		
Sign Control	Free			Free	Stop	
Grade	-2%			2%	0%	
Volume (veh/h)	245	141	177	700	0	0
Peak Hour Factor	0.88	0.88	0.90	0.90	1.00	1.00
Hourly flow rate (vph)	278	160	197	778	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			439	1450	278	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			439	1450	278	
tC, single (s)			4.1	6.4	6.2	
tC, 2 stage (s)						
tF (s)			2.2	3.5	3.3	
p0 queue free %			82	100	100	
cM capacity (veh/h)			1121	119	760	
Direction, Lane #	EB 1	EB 2	WB 1			
Volume Total	278	160	974			
Volume Left	0	0	197			
Volume Right	0	160	0			
cSH	1700	1700	1121			
Volume to Capacity	0.16	0.09	0.18			
Queue Length 95th (ft)	0	0	16			
Control Delay (s)	0.0	0.0	4.1			
Lane LOS			A			
Approach Delay (s)	0.0		4.1			
Approach LOS						
Intersection Summary						
Average Delay			2.8			
Intersection Capacity Utilization			66.2%	ICU Level of Service		C
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 9: Hayden Ave & Rte 2 WB Off-Ramp

2009 Existing AM

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑	↖	↗
Sign Control	Free			Free	Stop	
Grade	2%			0%	-2%	
Volume (veh/h)	111	0	0	405	338	521
Peak Hour Factor	0.87	0.87	0.81	0.81	0.93	0.93
Hourly flow rate (vph)	128	0	0	500	363	560
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					Raised	
Median storage (veh)					0	
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			128		628	128
vC1, stage 1 conf vol					128	
vC2, stage 2 conf vol					500	
vCu, unblocked vol			128		628	128
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)					5.4	
tF (s)			2.2		3.5	3.3
p0 queue free %			100		6	39
cM capacity (veh/h)			1458		385	923
Direction, Lane #	EB 1	WB 1	NB 1	NB 2		
Volume Total	128	500	363	560		
Volume Left	0	0	363	0		
Volume Right	0	0	0	560		
cSH	1700	1700	385	923		
Volume to Capacity	0.08	0.29	0.94	0.61		
Queue Length 95th (ft)	0	0	260	106		
Control Delay (s)	0.0	0.0	65.8	14.7		
Lane LOS			F	B		
Approach Delay (s)	0.0	0.0	34.8			
Approach LOS			D			
Intersection Summary						
Average Delay			20.7			
Intersection Capacity Utilization			46.7%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 9: Hayden Ave & Rte 2 WB Off-Ramp

2014 No Build AM

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑	↘	↗
Sign Control	Free			Free	Stop	
Grade	2%			0%	-2%	
Volume (veh/h)	128	0	0	482	533	548
Peak Hour Factor	0.87	0.87	0.81	0.81	0.93	0.93
Hourly flow rate (vph)	147	0	0	595	573	589
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					Raised	
Median storage (veh)					0	
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			147		742	147
vC1, stage 1 conf vol					147	
vC2, stage 2 conf vol					595	
vCu, unblocked vol			147		742	147
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)					5.4	
tF (s)			2.2		3.5	3.3
p0 queue free %			100		0	35
cM capacity (veh/h)			1435		346	900
Direction, Lane #	EB 1	WB 1	NB 1	NB 2		
Volume Total	147	595	573	589		
Volume Left	0	0	573	0		
Volume Right	0	0	0	589		
cSH	1700	1700	346	900		
Volume to Capacity	0.09	0.35	1.66	0.65		
Queue Length 95th (ft)	0	0	865	126		
Control Delay (s)	0.0	0.0	335.0	16.3		
Lane LOS			F	C		
Approach Delay (s)	0.0	0.0	173.4			
Approach LOS			F			
Intersection Summary						
Average Delay			105.8			
Intersection Capacity Utilization			61.6%	ICU Level of Service		
Analysis Period (min)			15	B		
















HCM Unsignalized Intersection Capacity Analysis
 9: Hayden Ave & Rte 2 WB Off-Ramp

2014 Build AM

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑	↖	↗
Sign Control	Free			Free	Stop	
Grade	2%			0%	-2%	
Volume (veh/h)	143	0	0	531	615	548
Peak Hour Factor	0.87	0.87	0.81	0.81	0.93	0.93
Hourly flow rate (vph)	164	0	0	656	661	589
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					Raised	
Median storage (veh)					0	
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			164		820	164
vC1, stage 1 conf vol					164	
vC2, stage 2 conf vol					656	
vCu, unblocked vol			164		820	164
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)					5.4	
tF (s)			2.2		3.5	3.3
p0 queue free %			100		0	33
cM capacity (veh/h)			1414		322	880
Direction, Lane #	EB 1	WB 1	NB 1	NB 2		
Volume Total	164	656	661	589		
Volume Left	0	0	661	0		
Volume Right	0	0	0	589		
cSH	1700	1700	322	880		
Volume to Capacity	0.10	0.39	2.05	0.67		
Queue Length 95th (ft)	0	0	1189	133		
Control Delay (s)	0.0	0.0	509.9	17.0		
Lane LOS			F	C		
Approach Delay (s)	0.0	0.0	277.6			
Approach LOS			F			
Intersection Summary						
Average Delay			167.7			
Intersection Capacity Utilization			68.7%		ICU Level of Service	C
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 10: Hayden Ave & Waltham Street

2009 Existing AM

							
Movement	EBL	EBR	NBL	NBT	SBT	SBR	
Lane Configurations				 	 	 	
Sign Control	Stop			Free	Free		
Grade	0%			2%	-2%		
Volume (veh/h)	39	592	264	425	993	141	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.95	0.95	
Hourly flow rate (vph)	42	637	284	457	1045	148	
Pedestrians	2						
Lane Width (ft)	16.0						
Walking Speed (ft/s)	4.0						
Percent Blockage	0						
Right turn flare (veh)							
Median type	None						
Median storage (veh)							
Upstream signal (ft)							
pX, platoon unblocked							
vC, conflicting volume	1918	599	1196				
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol	1918	599	1196				
tC, single (s)	6.8	6.9	4.1				
tC, 2 stage (s)							
tF (s)	3.5	3.3	2.2				
p0 queue free %	0	0	51				
cM capacity (veh/h)	30	444	578				
Direction, Lane #	EB 1	EB 2	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	42	637	284	228	228	697	497
Volume Left	42	0	284	0	0	0	0
Volume Right	0	637	0	0	0	0	148
cSH	30	444	578	1700	1700	1700	1700
Volume to Capacity	1.39	1.43	0.49	0.13	0.13	0.41	0.29
Queue Length 95th (ft)	119	791	67	0	0	0	0
Control Delay (s)	501.0	232.3	17.1	0.0	0.0	0.0	0.0
Lane LOS	F	F	C				
Approach Delay (s)	248.9		6.5		0.0		
Approach LOS	F						
Intersection Summary							
Average Delay	66.5						
Intersection Capacity Utilization	75.3%		ICU Level of Service			D	
Analysis Period (min)	15						

HCM Unsignalized Intersection Capacity Analysis
 10: Hayden Ave & Waltham Street

2014 No Build AM















Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			2%	-2%	
Volume (veh/h)	46	628	305	457	1044	178
Peak Hour Factor	0.93	0.93	0.93	0.93	0.95	0.95
Hourly flow rate (vph)	49	675	328	491	1099	187
Pedestrians				2	2	
Lane Width (ft)				12.0	12.0	
Walking Speed (ft/s)				4.0	4.0	
Percent Blockage				0	0	
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2096	645	1286			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2096	645	1286			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	0	0	39			
cM capacity (veh/h)	17	414	535			

Direction, Lane #	EB 1	EB 2	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	49	675	328	246	246	733	554
Volume Left	49	0	328	0	0	0	0
Volume Right	0	675	0	0	0	0	187
cSH	17	414	535	1700	1700	1700	1700
Volume to Capacity	2.85	1.63	0.61	0.14	0.14	0.43	0.33
Queue Length 95th (ft)	169	978	103	0	0	0	0
Control Delay (s)	1294.3	318.4	21.8	0.0	0.0	0.0	0.0
Lane LOS	F	F	C				
Approach Delay (s)	385.0		8.7	0.0			
Approach LOS	F						

Intersection Summary			
Average Delay	101.1		
Intersection Capacity Utilization	80.3%	ICU Level of Service	D
Analysis Period (min)	15		

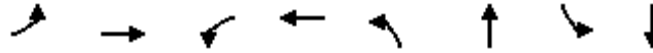
HCM Unsignalized Intersection Capacity Analysis
 10: Hayden Ave & Waltham Street

2014 Build AM

							
Movement	EBL	EBR	NBL	NBT	SBT	SBR	
Lane Configurations							
Sign Control	Stop			Free	Free		
Grade	0%			2%	-2%		
Volume (veh/h)	57	632	321	457	1044	211	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.95	0.95	
Hourly flow rate (vph)	61	680	345	491	1099	222	
Pedestrians				2	2		
Lane Width (ft)				12.0	12.0		
Walking Speed (ft/s)				4.0	4.0		
Percent Blockage				0	0		
Right turn flare (veh)							
Median type	None						
Median storage (veh)							
Upstream signal (ft)							
pX, platoon unblocked							
vC, conflicting volume	2148	663	1321				
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol	2148	663	1321				
tC, single (s)	6.8	6.9	4.1				
tC, 2 stage (s)							
tF (s)	3.5	3.3	2.2				
p0 queue free %	0	0	33				
cM capacity (veh/h)	14	403	519				
Direction, Lane #	EB 1	EB 2	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	61	680	345	246	246	733	588
Volume Left	61	0	345	0	0	0	0
Volume Right	0	680	0	0	0	0	222
cSH	14	403	519	1700	1700	1700	1700
Volume to Capacity	4.44	1.68	0.67	0.14	0.14	0.43	0.35
Queue Length 95th (ft)	Err	1019	122	0	0	0	0
Control Delay (s)	Err	342.6	24.6	0.0	0.0	0.0	0.0
Lane LOS	F	F	C				
Approach Delay (s)	1141.5		10.2		0.0		
Approach LOS	F						
Intersection Summary							
Average Delay			294.7				
Intersection Capacity Utilization			81.6%		ICU Level of Service		D
Analysis Period (min)	15						

Timings
11: Marrett Rd (Rte 2A) & Waltham Street

2009 Existing AM

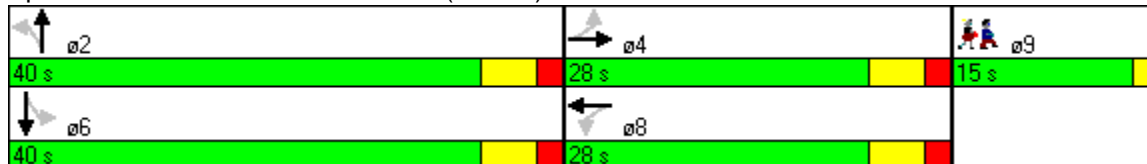


Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	ø9
Lane Configurations		↕		↕	↗	↖	↗	↖	
Volume (vph)	69	183	136	357	139	492	23	692	
Lane Group Flow (vph)	0	775	0	625	148	584	24	904	
Turn Type	Perm		Perm		Perm		Perm		
Protected Phases		4		8		2		6	9
Permitted Phases	4		8		2		6		
Detector Phases	4	4	8	8	2	2	6	6	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2.0
Minimum Split (s)	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	15.0
Total Split (s)	28.0	28.0	28.0	28.0	40.0	40.0	40.0	40.0	15.0
Total Split (%)	33.7%	33.7%	33.7%	33.7%	48.2%	48.2%	48.2%	48.2%	18%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.0
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	Max	Max	Max	Max	Max	Max	Max	Max	Max
v/c Ratio		1.98		2.88	1.64	0.76	0.14	1.16	
Control Delay		471.3		875.8	358.4	27.5	16.7	109.6	
Queue Delay		0.0		0.0	0.0	0.0	0.0	0.0	
Total Delay		471.3		875.8	358.4	27.5	16.7	109.6	
Queue Length 50th (ft)		~636		~567	~113	248	7	~563	
Queue Length 95th (ft)		#719		#628	#186	379	24	#786	
Internal Link Dist (ft)		2445		873		4387		1908	
Turn Bay Length (ft)					200		200		
Base Capacity (vph)		392		217	90	772	177	782	
Starvation Cap Reductn		0		0	0	0	0	0	
Spillback Cap Reductn		0		0	0	0	0	0	
Storage Cap Reductn		0		0	0	0	0	0	
Reduced v/c Ratio		1.98		2.88	1.64	0.76	0.14	1.16	

Intersection Summary



















Cycle Length: 83
 Actuated Cycle Length: 83
 Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
 Natural Cycle: 90
 Control Type: Pretimed
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 11: Marrett Rd (Rte 2A) & Waltham Street



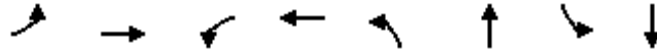
HCM Signalized Intersection Capacity Analysis
 11: Marrett Rd (Rte 2A) & Waltham Street

2009 Existing AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Frt		0.92			0.99		1.00	0.98		1.00	0.97	
Flt Protected		0.99			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1706			1832		1770	1781		1805	1801	
Flt Permitted		0.79			0.40		0.11	1.00		0.22	1.00	
Satd. Flow (perm)		1355			749		207	1781		409	1801	
Volume (vph)	69	183	360	136	357	38	139	492	57	23	692	167
Peak-hour factor, PHF	0.79	0.79	0.79	0.85	0.85	0.85	0.94	0.94	0.94	0.95	0.95	0.95
Adj. Flow (vph)	87	232	456	160	420	45	148	523	61	24	728	176
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	775	0	0	625	0	148	584	0	24	904	0
Heavy Vehicles (%)	4%	3%	1%	2%	1%	3%	2%	5%	5%	0%	2%	4%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		22.0			22.0		34.0	34.0		34.0	34.0	
Effective Green, g (s)		24.0			24.0		36.0	36.0		36.0	36.0	
Actuated g/C Ratio		0.29			0.29		0.43	0.43		0.43	0.43	
Clearance Time (s)		6.0			6.0		6.0	6.0		6.0	6.0	
Lane Grp Cap (vph)		392			217		90	772		177	781	
v/s Ratio Prot								0.33			0.50	
v/s Ratio Perm		0.57			c0.83		c0.72			0.06		
v/c Ratio		1.98			2.88		1.64	0.76		0.14	1.16	
Uniform Delay, d1		29.5			29.5		23.5	19.8		14.1	23.5	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		448.8			858.6		334.3	6.8		1.6	85.0	
Delay (s)		478.3			888.1		357.8	26.6		15.7	108.5	
Level of Service		F			F		F	C		B	F	
Approach Delay (s)		478.3			888.1			93.6			106.1	
Approach LOS		F			F			F			F	
Intersection Summary												
HCM Average Control Delay			357.1				HCM Level of Service				F	
HCM Volume to Capacity ratio			2.14									
Actuated Cycle Length (s)			83.0				Sum of lost time (s)			23.0		
Intersection Capacity Utilization			118.0%				ICU Level of Service				H	
Analysis Period (min)			15									
c Critical Lane Group												

Timings
11: Marrett Rd (Rte 2A) & Waltham Street

2014 No Build AM



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	ø9
Lane Configurations	↖	↗	↖	↗	↖	↗		↕	
Volume (vph)	87	198	180	422	139	501	23	736	
Lane Group Flow (vph)	92	587	189	484	146	619	0	1048	
Turn Type	Perm		pm+pt		pm+pt		Perm		
Protected Phases		4	3	8	5	2		6	9
Permitted Phases	4		8		2		6		
Detector Phases	4	4	3	8	5	2	6	6	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	15.0	15.0	8.0	15.0	8.0	15.0	15.0	15.0	15.0
Total Split (s)	55.0	55.0	15.0	70.0	10.0	65.0	55.0	55.0	15.0
Total Split (%)	36.7%	36.7%	10.0%	46.7%	6.7%	43.3%	36.7%	36.7%	10%
Yellow Time (s)	4.0	4.0	3.0	4.0	3.0	4.0	4.0	4.0	2.0
All-Red Time (s)	2.0	2.0	1.0	2.0	1.0	2.0	2.0	2.0	0.0
Lead/Lag	Lag	Lag	Lead		Lead		Lag	Lag	
Lead-Lag Optimize?									
Recall Mode	None	None	None	None	None	Max	Max	Max	None
v/c Ratio	0.36	0.94	0.96	0.54	1.11	0.79		1.07	
Control Delay	38.1	66.4	89.8	29.0	139.8	42.3		91.3	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0		0.0	
Total Delay	38.1	66.4	89.8	29.0	139.8	42.3		91.3	
Queue Length 50th (ft)	58	488	115	287	~92	449		~525	
Queue Length 95th (ft)	126	#846	#316	475	#273	#767		#777	
Internal Link Dist (ft)		2445		873		4387		1908	
Turn Bay Length (ft)	200		200		200				
Base Capacity (vph)	253	624	196	889	131	784		978	
Starvation Cap Reductn	0	0	0	0	0	0		0	
Spillback Cap Reductn	0	0	0	0	0	0		0	
Storage Cap Reductn	0	0	0	0	0	0		0	
Reduced v/c Ratio	0.36	0.94	0.96	0.54	1.11	0.79		1.07	

Intersection Summary

Cycle Length: 150

Actuated Cycle Length: 138

Natural Cycle: 130

Control Type: Actuated-Uncoordinated

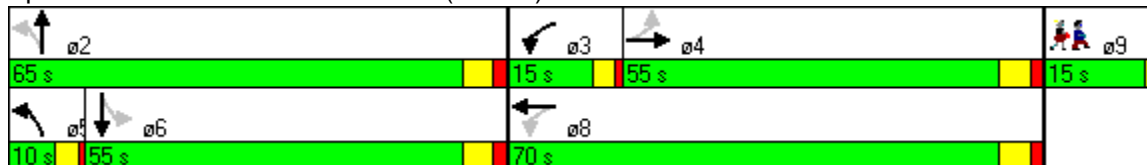
~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.





















Queue shown is maximum after two cycles.

Splits and Phases: 11: Marrett Rd (Rte 2A) & Waltham Street



HCM Signalized Intersection Capacity Analysis
 11: Marrett Rd (Rte 2A) & Waltham Street

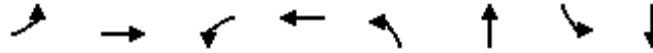
2014 No Build AM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			0.95	
Frt	1.00	0.90		1.00	0.99		1.00	0.98			0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)	1736	1687		1770	1855		1770	1769			3395	
Flt Permitted	0.41	1.00		0.10	1.00		0.08	1.00			0.84	
Satd. Flow (perm)	750	1687		184	1855		148	1769			2846	
Volume (vph)	87	198	360	180	422	38	139	501	87	23	736	237
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	92	208	379	189	444	40	146	527	92	24	775	249
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	92	587	0	189	484	0	146	619	0	0	1048	0
Heavy Vehicles (%)	4%	3%	1%	2%	1%	3%	2%	5%	5%	0%	2%	4%
Turn Type	Perm			pm+pt			pm+pt				Perm	
Protected Phases		4		3	8		5	2				6
Permitted Phases	4			8			2				6	
Actuated Green, G (s)	49.1	49.1		64.1	64.1		59.1	59.1			49.1	
Effective Green, g (s)	51.1	51.1		66.1	66.1		61.1	61.1			51.1	
Actuated g/C Ratio	0.37	0.37		0.47	0.47		0.44	0.44			0.37	
Clearance Time (s)	6.0	6.0		4.0	6.0		4.0	6.0			6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	275	618		212	878		134	774			1042	
v/s Ratio Prot		c0.35		c0.07	0.26		c0.05	0.35				
v/s Ratio Perm	0.12			0.35			c0.43				0.37	
v/c Ratio	0.33	0.95		0.89	0.55		1.09	0.80			1.01	
Uniform Delay, d1	32.0	43.0		31.1	26.2		33.3	34.0			44.2	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	0.7	24.1		33.9	0.8		103.8	8.5			29.3	
Delay (s)	32.7	67.1		65.0	26.9		137.1	42.4			73.5	
Level of Service	C	E		E	C		F	D			E	
Approach Delay (s)		62.4			37.6			60.5			73.5	
Approach LOS		E			D			E			E	
Intersection Summary												
HCM Average Control Delay			60.4			HCM Level of Service					E	
HCM Volume to Capacity ratio			1.00									
Actuated Cycle Length (s)			139.6			Sum of lost time (s)		16.4				
Intersection Capacity Utilization		116.1%				ICU Level of Service					H	
Analysis Period (min)			15									

c Critical Lane Group

Timings
11: Marrett Rd (Rte 2A) & Waltham Street

2014 Build AM



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	ø9
Lane Configurations	↖	↗	↖	↗	↖	↗		↕	
Volume (vph)	89	200	196	439	139	506	23	753	
Lane Group Flow (vph)	94	590	206	502	146	630	0	1083	
Turn Type	Perm		pm+pt		pm+pt		Perm		
Protected Phases		4	3	8	5	2		6	9
Permitted Phases	4		8		2		6		
Detector Phases	4	4	3	8	5	2	6	6	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	15.0	15.0	8.0	15.0	8.0	15.0	15.0	15.0	15.0
Total Split (s)	55.0	55.0	15.0	70.0	10.0	65.0	55.0	55.0	15.0
Total Split (%)	36.7%	36.7%	10.0%	46.7%	6.7%	43.3%	36.7%	36.7%	10%
Yellow Time (s)	4.0	4.0	3.0	4.0	3.0	4.0	4.0	4.0	2.0
All-Red Time (s)	2.0	2.0	1.0	2.0	1.0	2.0	2.0	2.0	0.0
Lead/Lag	Lag	Lag	Lead		Lead		Lag	Lag	
Lead-Lag Optimize?									
Recall Mode	None	None	None	None	None	Max	Max	Max	None
v/c Ratio	0.39	0.94	1.05	0.56	1.11	0.80		1.13	
Control Delay	39.5	67.0	112.6	29.5	139.8	43.2		110.0	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0		0.0	
Total Delay	39.5	67.0	112.6	29.5	139.8	43.2		110.0	
Queue Length 50th (ft)	60	491	~142	301	~92	462		~567	
Queue Length 95th (ft)	132	#852	#357	499	#273	#790		#823	
Internal Link Dist (ft)		2445		873		4387		1908	
Turn Bay Length (ft)	200		200		200				
Base Capacity (vph)	239	625	196	889	131	783		962	
Starvation Cap Reductn	0	0	0	0	0	0		0	
Spillback Cap Reductn	0	0	0	0	0	0		0	
Storage Cap Reductn	0	0	0	0	0	0		0	
Reduced v/c Ratio	0.39	0.94	1.05	0.56	1.11	0.80		1.13	

Intersection Summary

Cycle Length: 150

Actuated Cycle Length: 138

Natural Cycle: 150

Control Type: Actuated-Uncoordinated

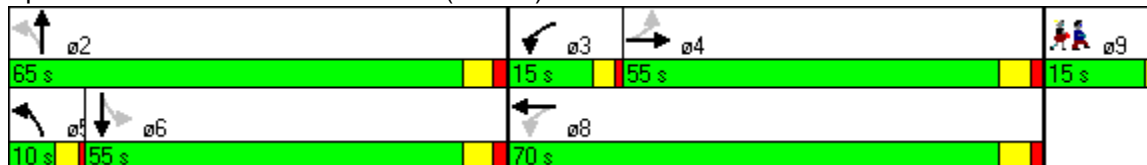
~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 11: Marrett Rd (Rte 2A) & Waltham Street



HCM Signalized Intersection Capacity Analysis
 11: Marrett Rd (Rte 2A) & Waltham Street

2014 Build AM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			0.95	
Frt	1.00	0.90		1.00	0.99		1.00	0.98			0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)	1736	1688		1770	1856		1770	1768			3390	
Flt Permitted	0.39	1.00		0.10	1.00		0.07	1.00			0.83	
Satd. Flow (perm)	714	1688		178	1856		135	1768			2809	
Volume (vph)	89	200	360	196	439	38	139	506	92	23	753	253
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	94	211	379	206	462	40	146	533	97	24	793	266
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	94	590	0	206	502	0	146	630	0	0	1083	0
Heavy Vehicles (%)	4%	3%	1%	2%	1%	3%	2%	5%	5%	0%	2%	4%
Turn Type	Perm			pm+pt			pm+pt				Perm	
Protected Phases		4		3	8		5	2				6
Permitted Phases	4			8			2				6	
Actuated Green, G (s)	49.1	49.1		64.1	64.1		59.1	59.1			49.1	
Effective Green, g (s)	51.1	51.1		66.1	66.1		61.1	61.1			51.1	
Actuated g/C Ratio	0.37	0.37		0.47	0.47		0.44	0.44			0.37	
Clearance Time (s)	6.0	6.0		4.0	6.0		4.0	6.0			6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	261	618		210	879		129	774			1028	
v/s Ratio Prot		0.35		c0.08	0.27		c0.05	0.36				
v/s Ratio Perm	0.13			c0.39			c0.44				0.39	
v/c Ratio	0.36	0.95		0.98	0.57		1.13	0.81			1.05	
Uniform Delay, d1	32.3	43.1		35.1	26.5		32.6	34.3			44.2	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	0.9	25.2		56.4	0.9		119.0	9.2			43.3	
Delay (s)	33.2	68.4		91.5	27.4		151.6	43.5			87.5	
Level of Service	C	E		F	C		F	D			F	
Approach Delay (s)		63.5			46.1			63.8			87.5	
Approach LOS		E			D			E			F	
Intersection Summary												
HCM Average Control Delay			67.8			HCM Level of Service					E	
HCM Volume to Capacity ratio			1.03									
Actuated Cycle Length (s)			139.6			Sum of lost time (s)			12.4			
Intersection Capacity Utilization		118.6%				ICU Level of Service					H	
Analysis Period (min)			15									

c Critical Lane Group

Timings
12: Waltham Street & Worthen Road

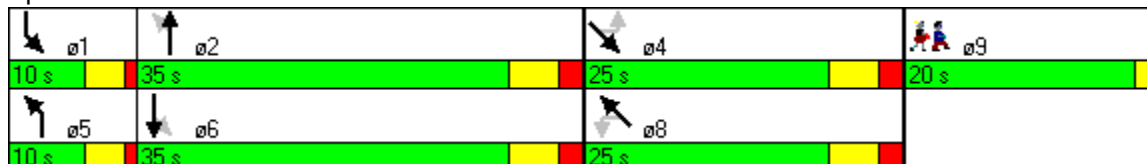
2009 Existing AM

Lane Group	NBL	NBT	SBL	SBT	SEL	SET	NWL	NWT	ø9
Lane Configurations									
Volume (vph)	237	309	36	474	46	45	13	102	
Lane Group Flow (vph)	272	369	38	552	0	545	0	359	
Turn Type	pm+pt		pm+pt		Perm		Perm		
Protected Phases	5	2	1	6		4		8	9
Permitted Phases	2		6		4		8		
Detector Phases	5	2	1	6	4	4	8	8	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2.0
Minimum Split (s)	8.0	15.0	8.0	15.0	15.0	15.0	15.0	15.0	20.0
Total Split (s)	10.0	35.0	10.0	35.0	25.0	25.0	25.0	25.0	20.0
Total Split (%)	11.1%	38.9%	11.1%	38.9%	27.8%	27.8%	27.8%	27.8%	22%
Yellow Time (s)	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	0.0
Lead/Lag	Lead	Lag	Lead	Lag					
Lead-Lag Optimize?									
Recall Mode	None	Max	None	Max	None	None	None	None	None
v/c Ratio	1.03	0.38	0.09	0.67		0.95dr		0.44	
Control Delay	82.3	12.3	7.7	20.2		28.1		21.9	
Queue Delay	0.0	0.0	0.0	0.0		0.0		0.0	
Total Delay	82.3	12.3	7.7	20.2		28.1		21.9	
Queue Length 50th (ft)	~65	74	6	181		107		64	
Queue Length 95th (ft)	#210	167	17	288		161		53	
Internal Link Dist (ft)		1908		1020		2764		1357	
Turn Bay Length (ft)	100		100						
Base Capacity (vph)	264	973	405	826		786		841	
Starvation Cap Reductn	0	0	0	0		0		0	
Spillback Cap Reductn	0	0	0	0		0		0	
Storage Cap Reductn	0	0	0	0		0		0	
Reduced v/c Ratio	1.03	0.38	0.09	0.67		0.69		0.43	

Intersection Summary





















Cycle Length: 90
 Actuated Cycle Length: 69.1
 Natural Cycle: 90
 Control Type: Actuated-Uncoordinated
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.
 dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Splits and Phases: 12: Waltham Street & Worthen Road



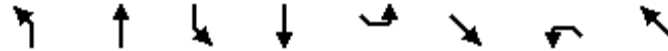
HCM Signalized Intersection Capacity Analysis
12: Waltham Street & Worthen Road

2009 Existing AM

												
Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			0.95			0.95	
Frt	1.00	0.99		1.00	0.99			0.88			0.94	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1719	1814		1752	1838			3087			3372	
Flt Permitted	0.26	1.00		0.52	1.00			0.88			0.89	
Satd. Flow (perm)	462	1814		961	1838			2730			3019	
Volume (vph)	237	309	12	36	474	45	46	45	400	13	102	72
Peak-hour factor, PHF	0.87	0.87	0.87	0.94	0.94	0.94	0.90	0.90	0.90	0.52	0.52	0.52
Adj. Flow (vph)	272	355	14	38	504	48	51	50	444	25	196	138
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	272	369	0	38	552	0	0	545	0	0	359	0
Heavy Vehicles (%)	5%	4%	8%	3%	2%	2%	2%	4%	2%	0%	1%	0%
Turn Type	pm+pt		pm+pt		Perm			Perm				
Protected Phases	5	2		1	6			4			8	
Permitted Phases	2			6			4			8		
Actuated Green, G (s)	41.1	35.1		33.9	31.5			18.0			18.0	
Effective Green, g (s)	43.1	37.1		35.9	33.5			20.0			20.0	
Actuated g/C Ratio	0.60	0.52		0.50	0.47			0.28			0.28	
Clearance Time (s)	4.0	6.0		4.0	6.0			6.0			6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	384	941		509	861			764			844	
v/s Ratio Prot	c0.06	0.20		0.00	0.30							
v/s Ratio Perm	c0.37			0.03				c0.20			0.12	
v/c Ratio	0.71	0.39		0.07	0.64			0.95dr			0.43	
Uniform Delay, d1	9.5	10.4		9.1	14.4			23.2			21.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	5.9	1.2		0.1	3.7			3.2			0.3	
Delay (s)	15.4	11.6		9.1	18.1			26.3			21.4	
Level of Service	B	B		A	B			C			C	
Approach Delay (s)		13.2			17.5			26.3			21.4	
Approach LOS		B			B			C			C	
Intersection Summary												
HCM Average Control Delay			19.1	HCM Level of Service				B				
HCM Volume to Capacity ratio			0.74									
Actuated Cycle Length (s)			71.5	Sum of lost time (s)				12.0				
Intersection Capacity Utilization			75.2%	ICU Level of Service				D				
Analysis Period (min)			15									
dr Defacto Right Lane. Recode with 1 though lane as a right lane.												
c Critical Lane Group												

Timings
12: Waltham Street & Worthen Road

2014 No Build AM



Lane Group	NBL	NBT	SBL	SBT	SEL	SET	NWL	NWT	ø9
Lane Configurations	↶	↷	↶	↷		↶↷		↶↷	
Volume (vph)	237	336	36	588	46	45	13	102	
Lane Group Flow (vph)	249	367	38	666	0	516	0	197	
Turn Type	pm+pt		pm+pt		Perm		Perm		
Protected Phases	5	2	1	6		4		8	9
Permitted Phases	2		6		4		8		
Detector Phases	5	2	1	6	4	4	8	8	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2.0
Minimum Split (s)	8.0	15.0	8.0	15.0	15.0	15.0	15.0	15.0	20.0
Total Split (s)	13.0	42.0	8.0	37.0	20.0	20.0	20.0	20.0	20.0
Total Split (%)	14.4%	46.7%	8.9%	41.1%	22.2%	22.2%	22.2%	22.2%	22%
Yellow Time (s)	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	0.0
Lead/Lag	Lead	Lag	Lead	Lag					
Lead-Lag Optimize?									
Recall Mode	None	Max	None	Max	None	None	None	None	None
v/c Ratio	0.80	0.36	0.08	0.80		1.20dr		0.34	
Control Delay	36.4	12.5	8.4	28.6		44.2		27.8	
Queue Delay	0.0	0.0	0.0	0.0		0.0		0.0	
Total Delay	36.4	12.5	8.4	28.6		44.2		27.8	
Queue Length 50th (ft)	53	83	5	225		111		37	
Queue Length 95th (ft)	#247	226	26	#602		#270		86	
Internal Link Dist (ft)		1908		1020		2764		1357	
Turn Bay Length (ft)	100		100						
Base Capacity (vph)	310	1024	467	829		608		586	
Starvation Cap Reductn	0	0	0	0		0		0	
Spillback Cap Reductn	0	0	0	0		0		0	
Storage Cap Reductn	0	0	0	0		0		0	
Reduced v/c Ratio	0.80	0.36	0.08	0.80		0.85		0.34	

Intersection Summary

Cycle Length: 90

Actuated Cycle Length: 74

Natural Cycle: 90

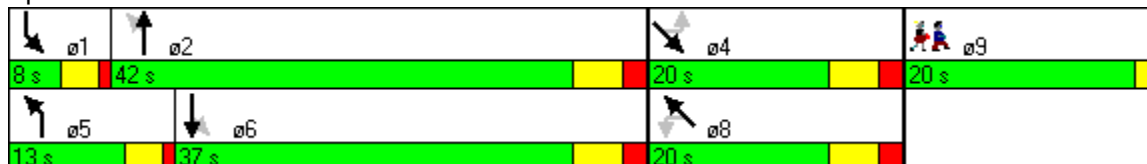
Control Type: Actuated-Uncoordinated

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.





















dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Splits and Phases: 12: Waltham Street & Worthen Road

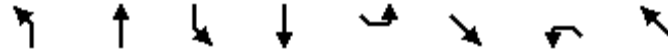


HCM Signalized Intersection Capacity Analysis
12: Waltham Street & Worthen Road

2014 No Build AM

												
Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			0.95			0.95	
Frt	1.00	0.99		1.00	0.99			0.88			0.94	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1719	1815		1752	1843			3086			3371	
Flt Permitted	0.15	1.00		0.54	1.00			0.90			0.87	
Satd. Flow (perm)	270	1815		1001	1843			2791			2941	
Volume (vph)	237	336	12	36	588	45	46	45	400	13	102	72
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	249	354	13	38	619	47	48	47	421	14	107	76
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	249	367	0	38	666	0	0	516	0	0	197	0
Heavy Vehicles (%)	5%	4%	8%	3%	2%	2%	2%	4%	2%	0%	1%	0%
Turn Type	pm+pt		pm+pt		Perm			Perm				
Protected Phases	5	2		1	6			4			8	
Permitted Phases	2			6			4			8		
Actuated Green, G (s)	46.0	39.7		35.2	32.9			14.1			14.1	
Effective Green, g (s)	48.0	41.7		37.2	34.9			16.1			16.1	
Actuated g/C Ratio	0.62	0.54		0.48	0.45			0.21			0.21	
Clearance Time (s)	4.0	6.0		4.0	6.0			6.0			6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	339	982		505	834			583			614	
v/s Ratio Prot	c0.09	0.20		0.00	c0.36							
v/s Ratio Perm	0.37			0.03				c0.18			0.07	
v/c Ratio	0.73	0.37		0.08	0.80			1.20dr			0.32	
Uniform Delay, d1	12.4	10.2		10.6	18.1			29.6			25.9	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	8.0	1.1		0.1	7.9			14.9			0.3	
Delay (s)	20.4	11.3		10.6	26.0			44.5			26.2	
Level of Service	C	B		B	C			D			C	
Approach Delay (s)		15.0			25.1			44.5			26.2	
Approach LOS		B			C			D			C	
Intersection Summary												
HCM Average Control Delay			27.1			HCM Level of Service					C	
HCM Volume to Capacity ratio			0.81									
Actuated Cycle Length (s)			77.1			Sum of lost time (s)			17.0			
Intersection Capacity Utilization			81.2%			ICU Level of Service					D	
Analysis Period (min)			15									
dr Defacto Right Lane. Recode with 1 though lane as a right lane.												
c Critical Lane Group												

Timings
12: Waltham Street & Worthen Road



Lane Group	NBL	NBT	SBL	SBT	SEL	SET	NWL	NWT	ø9
Lane Configurations	↖	↗	↖	↗		↖↗		↖↗	
Volume (vph)	237	344	36	621	46	45	13	102	
Lane Group Flow (vph)	249	375	38	701	0	516	0	197	
Turn Type	pm+pt		pm+pt		Perm		Perm		
Protected Phases	5	2	1	6		4		8	9
Permitted Phases	2		6		4		8		
Detector Phases	5	2	1	6	4	4	8	8	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2.0
Minimum Split (s)	8.0	15.0	8.0	15.0	15.0	15.0	15.0	15.0	20.0
Total Split (s)	13.0	42.0	8.0	37.0	20.0	20.0	20.0	20.0	20.0
Total Split (%)	14.4%	46.7%	8.9%	41.1%	22.2%	22.2%	22.2%	22.2%	22%
Yellow Time (s)	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	0.0
Lead/Lag	Lead	Lag	Lead	Lag					
Lead-Lag Optimize?									
Recall Mode	None	Max	None	Max	None	None	None	None	None
v/c Ratio	0.80	0.37	0.08	0.84		1.20dr		0.34	
Control Delay	36.4	12.6	8.4	31.3		44.2		27.8	
Queue Delay	0.0	0.0	0.0	0.0		0.0		0.0	
Total Delay	36.4	12.6	8.4	31.3		44.2		27.8	
Queue Length 50th (ft)	53	86	5	244		111		37	
Queue Length 95th (ft)	#247	232	26	#645		#270		86	
Internal Link Dist (ft)		1908		1020		2764		1357	
Turn Bay Length (ft)	100		100						
Base Capacity (vph)	310	1024	459	830		608		586	
Starvation Cap Reductn	0	0	0	0		0		0	
Spillback Cap Reductn	0	0	0	0		0		0	
Storage Cap Reductn	0	0	0	0		0		0	
Reduced v/c Ratio	0.80	0.37	0.08	0.84		0.85		0.34	

Intersection Summary

Cycle Length: 90

Actuated Cycle Length: 74

Natural Cycle: 100

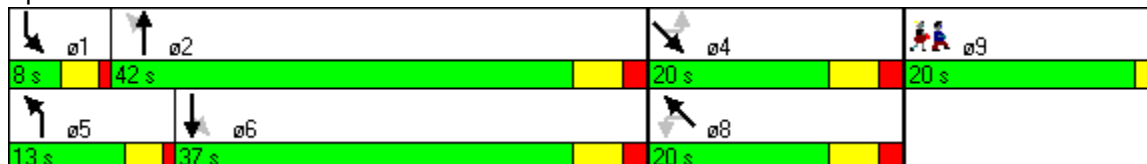
Control Type: Actuated-Uncoordinated

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.





















dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Splits and Phases: 12: Waltham Street & Worthen Road



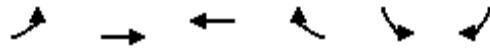
HCM Signalized Intersection Capacity Analysis
12: Waltham Street & Worthen Road

2014 Build AM

												
Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			0.95			0.95	
Frt	1.00	0.99		1.00	0.99			0.88			0.94	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1719	1815		1752	1844			3086			3371	
Flt Permitted	0.12	1.00		0.54	1.00			0.90			0.87	
Satd. Flow (perm)	222	1815		994	1844			2791			2941	
Volume (vph)	237	344	12	36	621	45	46	45	400	13	102	72
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	249	362	13	38	654	47	48	47	421	14	107	76
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	249	375	0	38	701	0	0	516	0	0	197	0
Heavy Vehicles (%)	5%	4%	8%	3%	2%	2%	2%	4%	2%	0%	1%	0%
Turn Type	pm+pt			pm+pt			Perm			Perm		
Protected Phases	5	2		1	6			4			8	
Permitted Phases	2			6			4			8		
Actuated Green, G (s)	46.0	39.7		35.2	32.9			14.1			14.1	
Effective Green, g (s)	48.0	41.7		37.2	34.9			16.1			16.1	
Actuated g/C Ratio	0.62	0.54		0.48	0.45			0.21			0.21	
Clearance Time (s)	4.0	6.0		4.0	6.0			6.0			6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	315	982		502	835			583			614	
v/s Ratio Prot	c0.09	0.21		0.00	0.38							
v/s Ratio Perm	c0.40			0.03				c0.18			0.07	
v/c Ratio	0.79	0.38		0.08	0.84			1.20dr			0.32	
Uniform Delay, d1	15.4	10.2		10.6	18.6			29.6			25.9	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	12.7	1.1		0.1	9.9			14.9			0.3	
Delay (s)	28.1	11.4		10.6	28.5			44.5			26.2	
Level of Service	C	B		B	C			D			C	
Approach Delay (s)		18.0			27.6			44.5			26.2	
Approach LOS		B			C			D			C	
Intersection Summary												
HCM Average Control Delay			28.8	HCM Level of Service				C				
HCM Volume to Capacity ratio			0.80									
Actuated Cycle Length (s)			77.1	Sum of lost time (s)				13.0				
Intersection Capacity Utilization			82.9%	ICU Level of Service				E				
Analysis Period (min)			15									
dr Defacto Right Lane. Recode with 1 though lane as a right lane.												
c Critical Lane Group												

HCM Unsignalized Intersection Capacity Analysis
 1: Concord Ave & Rte 2 EB Ramp

2009 Existing PM



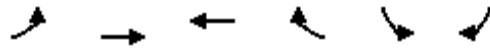
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↶	↷			↷
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	308	158	105	0	0	222
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	335	172	114	0	0	241
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None		
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	114				955	114
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	114				955	114
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	77				100	74
cM capacity (veh/h)	1475				221	938

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	507	114	241
Volume Left	335	0	0
Volume Right	0	0	241
cSH	1475	1700	938
Volume to Capacity	0.23	0.07	0.26
Queue Length 95th (ft)	22	0	26
Control Delay (s)	6.1	0.0	10.2
Lane LOS	A		B
Approach Delay (s)	6.1	0.0	10.2
Approach LOS			B

Intersection Summary			
Average Delay		6.4	
Intersection Capacity Utilization	35.4%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
 1: Concord Ave & Rte 2 EB Ramp

2014 No Build PM



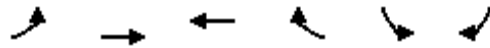
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↶	↷			↷
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	428	212	127	1	0	281
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	465	230	138	1	0	305
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	139				1299	139
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	139				1299	139
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	68				100	66
cM capacity (veh/h)	1444				121	910

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	696	139	305
Volume Left	465	0	0
Volume Right	0	1	305
cSH	1444	1700	910
Volume to Capacity	0.32	0.08	0.34
Queue Length 95th (ft)	35	0	37
Control Delay (s)	6.9	0.0	10.9
Lane LOS	A		B
Approach Delay (s)	6.9	0.0	10.9
Approach LOS			B

Intersection Summary			
Average Delay		7.1	
Intersection Capacity Utilization	48.3%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
 1: Concord Ave & Rte 2 EB Ramp

2014 Build PM



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↶	↷			↶
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	503	215	129	1	0	313
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	547	234	140	1	0	340
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	141				1468	141
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	141				1468	141
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	62				100	62
cM capacity (veh/h)	1442				87	907

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	780	141	340
Volume Left	547	0	0
Volume Right	0	1	340
cSH	1442	1700	907
Volume to Capacity	0.38	0.08	0.38
Queue Length 95th (ft)	45	0	44
Control Delay (s)	7.5	0.0	11.3
Lane LOS	A		B
Approach Delay (s)	7.5	0.0	11.3
Approach LOS			B

Intersection Summary			
Average Delay		7.7	
Intersection Capacity Utilization	52.7%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
2: Concord Ave & Spring Street

2009 Existing PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↶	↷	↷		↶	↷
Sign Control	Stop		Free		Free	Free
Grade	2%		0%			-2%
Volume (veh/h)	119	208	474	350	116	264
Peak Hour Factor	0.90	0.90	0.77	0.77	0.94	0.94
Hourly flow rate (vph)	132	231	616	455	123	281
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1371	843			1070	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1371	843			1070	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	36			81	
cM capacity (veh/h)	130	364			651	
Direction, Lane #	WB 1	WB 2	NB 1	SB 1	SB 2	
Volume Total	132	231	1070	123	281	
Volume Left	132	0	0	123	0	
Volume Right	0	231	455	0	0	
cSH	130	364	1700	651	1700	
Volume to Capacity	1.01	0.64	0.63	0.19	0.17	
Queue Length 95th (ft)	179	104	0	17	0	
Control Delay (s)	147.8	30.7	0.0	11.8	0.0	
Lane LOS	F	D		B		
Approach Delay (s)	73.3		0.0	3.6		
Approach LOS	F					
Intersection Summary						
Average Delay			15.3			
Intersection Capacity Utilization			69.3%		ICU Level of Service	C
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
2: Concord Ave & Spring Street

2014 No Build PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↻		↰	↱
Sign Control	Stop		Free			Free
Grade	2%		0%			-2%
Volume (veh/h)	126	282	509	368	272	337
Peak Hour Factor	0.93	0.93	0.86	0.86	0.88	0.88
Hourly flow rate (vph)	135	303	592	428	309	383
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1807	806			1020	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1807	806			1020	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	21			55	
cM capacity (veh/h)	47	382			680	
Direction, Lane #	WB 1	WB 2	NB 1	SB 1	SB 2	
Volume Total	135	303	1020	309	383	
Volume Left	135	0	0	309	0	
Volume Right	0	303	428	0	0	
cSH	47	382	1700	680	1700	
Volume to Capacity	2.86	0.79	0.60	0.45	0.23	
Queue Length 95th (ft)	363	171	0	59	0	
Control Delay (s)	1023.4	42.4	0.0	14.6	0.0	
Lane LOS	F	E		B		
Approach Delay (s)	345.3		0.0	6.5		
Approach LOS	F					
Intersection Summary						
Average Delay			72.5			
Intersection Capacity Utilization			81.3%		ICU Level of Service	D
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
2: Concord Ave & Spring Street






















2014 Build PM



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↶	↷	↷		↶	↷
Sign Control	Stop		Free			Free
Grade	2%		0%			-2%
Volume (veh/h)	126	316	513	368	350	349
Peak Hour Factor	0.93	0.93	0.86	0.86	0.88	0.88
Hourly flow rate (vph)	135	340	597	428	398	397
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	Raised					
Median storage (veh)	0					
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2003	810			1024	
vC1, stage 1 conf vol	810					
vC2, stage 2 conf vol	1192					
vCu, unblocked vol	2003	810			1024	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	10			41	
cM capacity (veh/h)	69	380			678	
Direction, Lane #	WB 1	WB 2	NB 1	SB 1	SB 2	
Volume Total	135	340	1024	398	397	
Volume Left	135	0	0	398	0	
Volume Right	0	340	428	0	0	
cSH	69	380	1700	678	1700	
Volume to Capacity	1.95	0.90	0.60	0.59	0.23	
Queue Length 95th (ft)	309	227	0	96	0	
Control Delay (s)	574.1	57.1	0.0	17.6	0.0	
Lane LOS	F	F		C		
Approach Delay (s)	204.5		0.0	8.8		
Approach LOS	F					
Intersection Summary						
Average Delay			45.4			
Intersection Capacity Utilization			85.8%		ICU Level of Service	E
Analysis Period (min)			15			






















HCM Unsignalized Intersection Capacity Analysis
3: Patriot Way & Spring Street

2009 Existing PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control	Stop		Stop		Free		Free					
Grade	0%		0%		0%		-2%					
Volume (veh/h)	13	18	24	98	5	124	5	523	162	53	256	2
Peak Hour Factor	0.60	0.60	0.60	0.91	0.91	0.91	0.87	0.87	0.87	0.88	0.88	0.88
Hourly flow rate (vph)	22	30	40	108	5	136	6	601	186	60	291	2
Pedestrians	6		4		1							
Lane Width (ft)	12.0		13.0		12.0							
Walking Speed (ft/s)	4.0		4.0		4.0							
Percent Blockage	0		0		0							
Right turn flare (veh)												
Median type	None		None									
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1170	1221	299	1177	1129	698	299			791		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1170	1221	299	1177	1129	698	299			791		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	80	82	95	15	97	69	100			93		
cM capacity (veh/h)	106	164	736	127	187	439	1256			826		
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2			
Volume Total	22	70	108	5	136	6	787	60	293			
Volume Left	22	0	108	0	0	6	0	60	0			
Volume Right	0	40	0	0	136	0	186	0	2			
cSH	106	296	127	187	439	1256	1700	826	1700			
Volume to Capacity	0.20	0.24	0.85	0.03	0.31	0.00	0.46	0.07	0.17			
Queue Length 95th (ft)	18	23	131	2	33	0	0	6	0			
Control Delay (s)	47.3	20.9	108.0	24.9	16.9	7.9	0.0	9.7	0.0			
Lane LOS	E	C	F	C	C	A		A				
Approach Delay (s)	27.1		56.4			0.1		1.7				
Approach LOS	D		F									
Intersection Summary												
Average Delay			11.5									
Intersection Capacity Utilization			62.8%		ICU Level of Service						B	
Analysis Period (min)			15									






















HCM Unsignalized Intersection Capacity Analysis
3: Patriot Way & Spring Street

2014 No Build PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control	Stop		Stop		Free		Free					
Grade	0%		0%		0%		-2%					
Volume (veh/h)	177	276	188	133	26	146	63	554	183	58	285	36
Peak Hour Factor	0.92	0.92	0.92	0.94	0.94	0.94	0.84	0.84	0.84	0.87	0.87	0.87
Hourly flow rate (vph)	192	300	204	141	28	155	75	660	218	67	328	41
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type	None			None								
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1460	1509	348	1734	1421	768	369			877		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1460	1509	348	1734	1421	768	369			877		
tC, single (s)	7.2	6.6	6.3	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.6	4.1	3.4	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	70	0	76	61	94			91		
cM capacity (veh/h)	47	101	686	0	117	403	1195			770		
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2			
Volume Total	192	504	141	28	155	75	877	67	369			
Volume Left	192	0	141	0	0	75	0	67	0			
Volume Right	0	204	0	0	155	0	218	0	41			
cSH	47	154	0	117	403	1195	1700	770	1700			
Volume to Capacity	4.08	3.27	Err	0.24	0.39	0.06	0.52	0.09	0.22			
Queue Length 95th (ft)	Err	Err	Err	22	44	5	0	7	0			
Control Delay (s)	Err	Err	Err	44.9	19.4	8.2	0.0	10.1	0.0			
Lane LOS	F	F	F	E	C	A		B				
Approach Delay (s)	Err		Err			0.6		1.5				
Approach LOS	F		F									
Intersection Summary												
Average Delay			Err									
Intersection Capacity Utilization			90.3%		ICU Level of Service						E	
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
 3: Patriot Way & Spring Street

2014 Build PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control	Stop			Stop				Free			Free	
Grade	0%			0%				0%			-2%	
Volume (veh/h)	222	441	278	133	64	146	101	554	183	58	285	55
Peak Hour Factor	0.92	0.92	0.92	0.94	0.94	0.94	0.84	0.84	0.84	0.87	0.87	0.87
Hourly flow rate (vph)	241	479	302	141	68	155	120	660	218	67	328	63
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type	None			None								
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1582	1610	359	2012	1533	768	391			877		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1582	1610	359	2012	1533	768	391			877		
tC, single (s)	7.2	6.6	6.3	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.6	4.1	3.4	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	55	0	29	61	90			91		
cM capacity (veh/h)	20	84	676	0	96	403	1173			770		
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2			
Volume Total	241	782	141	68	155	120	877	67	391			
Volume Left	241	0	141	0	0	120	0	67	0			
Volume Right	0	302	0	0	155	0	218	0	63			
cSH	20	127	0	96	403	1173	1700	770	1700			
Volume to Capacity	12.19	6.16	Err	0.71	0.39	0.10	0.52	0.09	0.23			
Queue Length 95th (ft)	Err	Err	Err	90	44	9	0	7	0			
Control Delay (s)	Err	Err	Err	104.6	19.4	8.4	0.0	10.1	0.0			
Lane LOS	F	F	F	F	C	A		B				
Approach Delay (s)	9999.0		Err			1.0		1.5				
Approach LOS	F		F									
Intersection Summary												
Average Delay			Err									
Intersection Capacity Utilization			104.5%			ICU Level of Service			G			
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis
 4: Shade Street & Spring Street

2009 Existing PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	3	32	93	598	243	4
Peak Hour Factor	0.90	0.90	0.74	0.74	0.79	0.79
Hourly flow rate (vph)	3	36	126	808	308	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1370	310	313			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1370	310	313			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	95	90			
cM capacity (veh/h)	145	730	1248			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	39	934	313			
Volume Left	3	126	0			
Volume Right	36	0	5			
cSH	543	1248	1700			
Volume to Capacity	0.07	0.10	0.18			
Queue Length 95th (ft)	6	8	0			
Control Delay (s)	12.1	2.5	0.0			
Lane LOS	B	A				
Approach Delay (s)	12.1	2.5	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay			2.2			
Intersection Capacity Utilization		63.0%		ICU Level of Service		B
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 4: Shade Street & Spring Street

2014 No Build PM



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	↔			↑	↑	
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	4	34	98	838	298	5
Peak Hour Factor	0.74	0.74	0.79	0.79	0.90	0.90
Hourly flow rate (vph)	5	46	124	1061	331	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1643	334	337			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1643	334	337			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	95	94	90			
cM capacity (veh/h)	99	708	1223			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	51	1185	337			
Volume Left	5	124	0			
Volume Right	46	0	6			
cSH	429	1223	1700			
Volume to Capacity	0.12	0.10	0.20			
Queue Length 95th (ft)	10	8	0			
Control Delay (s)	14.5	2.9	0.0			
Lane LOS	B	A				
Approach Delay (s)	14.5	2.9	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay			2.6			
Intersection Capacity Utilization	78.8%		ICU Level of Service	D		
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 4: Shade Street & Spring Street

2014 Build PM

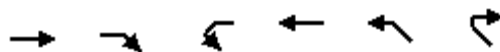


Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	4	34	98	883	317	5
Peak Hour Factor	0.74	0.74	0.79	0.79	0.90	0.90
Hourly flow rate (vph)	5	46	124	1118	352	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1721	355	358			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1721	355	358			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	94	93	90			
cM capacity (veh/h)	88	689	1201			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	51	1242	358			
Volume Left	5	124	0			
Volume Right	46	0	6			
cSH	401	1201	1700			
Volume to Capacity	0.13	0.10	0.21			
Queue Length 95th (ft)	11	9	0			
Control Delay (s)	15.3	3.1	0.0			
Lane LOS	C	A				
Approach Delay (s)	15.3	3.1	0.0			
Approach LOS	C					
Intersection Summary						
Average Delay			2.8			
Intersection Capacity Utilization	82.2%		ICU Level of Service	E		
Analysis Period (min)			15			

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↗			↖	↘	↗
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	369	189	112	229	272	360
Peak Hour Factor	0.91	0.91	0.94	0.94	0.89	0.89
Hourly flow rate (vph)	405	208	119	244	306	404
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			613		991	509
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			613		991	509
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			88		0	28
cM capacity (veh/h)			966		239	564
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	613	363	710			
Volume Left	0	119	306			
Volume Right	208	0	404			
cSH	1700	966	356			
Volume to Capacity	0.36	0.12	2.00			
Queue Length 95th (ft)	0	11	1241			
Control Delay (s)	0.0	3.9	482.5			
Lane LOS		A	F			
Approach Delay (s)	0.0	3.9	482.5			
Approach LOS			F			
Intersection Summary						
Average Delay			204.1			
Intersection Capacity Utilization			96.4%	ICU Level of Service	F	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
6: Marrett Rd (Rte 2A) & Bridge St

2009 Existing PM



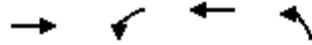
Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations	↑			↑	↘	↘
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	729	0	0	338	3	4
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	729	0	0	338	3	4
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			729		1067	729
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			729		1067	729
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		99	99
cM capacity (veh/h)			875		246	423

Direction, Lane #	EB 1	WB 1	NW 1
Volume Total	729	338	7
Volume Left	0	0	3
Volume Right	0	0	4
cSH	1700	1700	323
Volume to Capacity	0.43	0.20	0.02
Queue Length 95th (ft)	0	0	2
Control Delay (s)	0.0	0.0	16.4
Lane LOS			C
Approach Delay (s)	0.0	0.0	16.4
Approach LOS			C

Intersection Summary			
Average Delay		0.1	
Intersection Capacity Utilization	48.4%	ICU Level of Service	A
Analysis Period (min)		15	

Timings
5: Marrett Rd (Rte 2A) & Spring Street

2014 No Build PM



Lane Group	EBT	WBL	WBT	NBL	ø9
Lane Configurations	↻	↻	↻	↻	
Volume (vph)	388	139	242	414	
Lane Group Flow (vph)	662	162	281	961	
Turn Type	pm+pt				
Protected Phases	4	3	8	2	9
Permitted Phases	8				
Detector Phases	4	3	8	2	
Minimum Initial (s)	4.0	4.0	4.0	4.0	2.0
Minimum Split (s)	22.0	10.0	22.0	22.0	15.0
Total Split (s)	50.0	10.0	60.0	60.0	21.0
Total Split (%)	35.5%	7.1%	42.6%	42.6%	15%
Yellow Time (s)	4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	2.0	2.0	2.0	2.0	0.0
Lead/Lag	Lag	Lead			
Lead-Lag Optimize?	Yes	Yes			
Recall Mode	None	None	None	Min	None
v/c Ratio	1.00	1.11	0.33	1.19	
Control Delay	71.7	134.1	23.7	129.6	
Queue Delay	0.0	0.0	0.0	0.0	
Total Delay	71.7	134.1	23.7	129.6	
Queue Length 50th (ft)	487	~91	134	~869	
Queue Length 95th (ft)	#883	#254	230	#1320	
Internal Link Dist (ft)	2551		834	1808	
Turn Bay Length (ft)	150				
Base Capacity (vph)	664	146	840	805	
Starvation Cap Reductn	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	
Storage Cap Reductn	0	0	0	0	
Reduced v/c Ratio	1.00	1.11	0.33	1.19	

Intersection Summary

Cycle Length: 141

Actuated Cycle Length: 123

Natural Cycle: 150

Control Type: Actuated-Uncoordinated

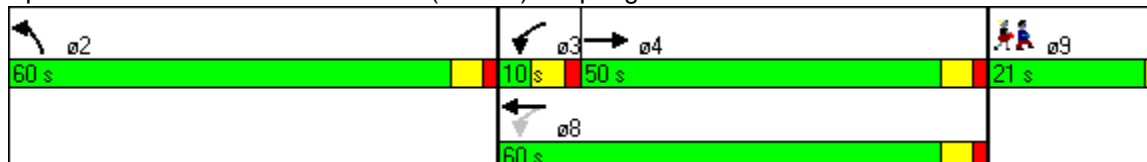
~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

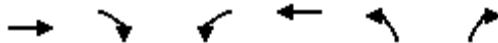
Queue shown is maximum after two cycles.

Splits and Phases: 5: Marrett Rd (Rte 2A) & Spring Street



HCM Signalized Intersection Capacity Analysis
5: Marrett Rd (Rte 2A) & Spring Street

2014 No Build PM



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↩		↩	↩	↩	↩
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0	4.0	
Lane Util. Factor	1.00		1.00	1.00	1.00	
Frbp, ped/bikes	0.99		1.00	1.00	1.00	
Flpb, ped/bikes	1.00		1.00	1.00	1.00	
Frt	0.95		1.00	1.00	0.93	
Flt Protected	1.00		0.95	1.00	0.98	
Satd. Flow (prot)	1736		1748	1840	1706	
Flt Permitted	1.00		0.08	1.00	0.98	
Satd. Flow (perm)	1736		147	1840	1706	
Volume (vph)	388	221	139	242	414	470
Peak-hour factor, PHF	0.92	0.92	0.86	0.86	0.92	0.92
Adj. Flow (vph)	422	240	162	281	450	511
RTOR Reduction (vph)	14	0	0	0	26	0
Lane Group Flow (vph)	648	0	162	281	935	0
Confl. Peds. (#/hr)		2	2			
Heavy Vehicles (%)	2%	2%	2%	2%	1%	1%
Bus Blockages (#/hr)	3	3	3	3	0	0
Turn Type			pm+pt			
Protected Phases	4		3	8	2	
Permitted Phases			8			
Actuated Green, G (s)	44.1		54.1	54.1	54.1	
Effective Green, g (s)	46.1		56.1	56.1	56.1	
Actuated g/C Ratio	0.37		0.45	0.45	0.45	
Clearance Time (s)	6.0		6.0	6.0	6.0	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)	642		143	828	768	
v/s Ratio Prot	0.37		c0.05	0.15	c0.55	
v/s Ratio Perm			c0.45			
v/c Ratio	1.01		1.13	0.34	1.22	
Uniform Delay, d1	39.2		30.1	22.2	34.2	
Progression Factor	1.00		1.00	1.00	1.00	
Incremental Delay, d2	37.9		115.4	0.2	109.4	
Delay (s)	77.2		145.5	22.5	143.6	
Level of Service	E		F	C	F	
Approach Delay (s)	77.2			67.5	143.6	
Approach LOS	E			E	F	

Intersection Summary

HCM Average Control Delay	106.0	HCM Level of Service	F
HCM Volume to Capacity ratio	1.16		
Actuated Cycle Length (s)	124.6	Sum of lost time (s)	12.4
Intersection Capacity Utilization	103.4%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Timings
5: Marrett Rd (Rte 2A) & Spring Street

2014 Build PM



Lane Group	EBT	WBL	WBT	NBL	ø9
Lane Configurations	↻	↻	↻	↻	
Volume (vph)	388	149	242	444	
Lane Group Flow (vph)	673	173	281	1010	
Turn Type	pm+pt				
Protected Phases	4	3	8	2	9
Permitted Phases	8				
Detector Phases	4	3	8	2	
Minimum Initial (s)	4.0	4.0	4.0	4.0	2.0
Minimum Split (s)	22.0	10.0	22.0	22.0	15.0
Total Split (s)	50.0	10.0	60.0	60.0	21.0
Total Split (%)	35.5%	7.1%	42.6%	42.6%	15%
Yellow Time (s)	4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	2.0	2.0	2.0	2.0	0.0
Lead/Lag	Lag	Lead			
Lead-Lag Optimize?	Yes	Yes			
Recall Mode	None	None	None	Min	None
v/c Ratio	1.01	1.18	0.33	1.25	
Control Delay	75.6	159.4	23.7	154.5	
Queue Delay	0.0	0.0	0.0	0.0	
Total Delay	75.6	159.4	23.7	154.5	
Queue Length 50th (ft)	501	~109	134	~950	
Queue Length 95th (ft)	#903	#278	230	#1413	
Internal Link Dist (ft)	2551		834	1808	
Turn Bay Length (ft)	150				
Base Capacity (vph)	664	146	840	805	
Starvation Cap Reductn	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	
Storage Cap Reductn	0	0	0	0	
Reduced v/c Ratio	1.01	1.18	0.33	1.25	

Intersection Summary

Cycle Length: 141

Actuated Cycle Length: 123

Natural Cycle: 150

Control Type: Actuated-Uncoordinated

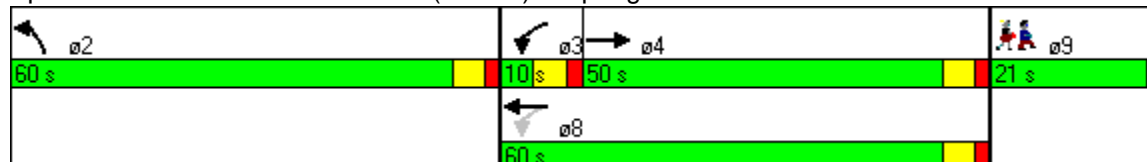
~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

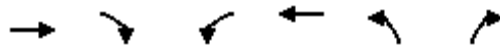
Queue shown is maximum after two cycles.

Splits and Phases: 5: Marrett Rd (Rte 2A) & Spring Street



HCM Signalized Intersection Capacity Analysis
5: Marrett Rd (Rte 2A) & Spring Street

2014 Build PM



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↩		↩	↩	↩	↩
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0	4.0	
Lane Util. Factor	1.00		1.00	1.00	1.00	
Frbp, ped/bikes	0.99		1.00	1.00	1.00	
Flpb, ped/bikes	1.00		1.00	1.00	1.00	
Frt	0.95		1.00	1.00	0.93	
Flt Protected	1.00		0.95	1.00	0.98	
Satd. Flow (prot)	1733		1748	1840	1708	
Flt Permitted	1.00		0.08	1.00	0.98	
Satd. Flow (perm)	1733		147	1840	1708	
Volume (vph)	388	231	149	242	444	485
Peak-hour factor, PHF	0.92	0.92	0.86	0.86	0.92	0.92
Adj. Flow (vph)	422	251	173	281	483	527
RTOR Reduction (vph)	14	0	0	0	25	0
Lane Group Flow (vph)	659	0	173	281	985	0
Confl. Peds. (#/hr)		2	2			
Heavy Vehicles (%)	2%	2%	2%	2%	1%	1%
Bus Blockages (#/hr)	3	3	3	3	0	0
Turn Type			pm+pt			
Protected Phases	4		3	8	2	
Permitted Phases			8			
Actuated Green, G (s)	44.1		54.1	54.1	54.1	
Effective Green, g (s)	46.1		56.1	56.1	56.1	
Actuated g/C Ratio	0.37		0.45	0.45	0.45	
Clearance Time (s)	6.0		6.0	6.0	6.0	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)	641		143	828	769	
v/s Ratio Prot	0.38		c0.06	0.15	c0.58	
v/s Ratio Perm			c0.49			
v/c Ratio	1.03		1.21	0.34	1.28	
Uniform Delay, d1	39.2		30.4	22.2	34.2	
Progression Factor	1.00		1.00	1.00	1.00	
Incremental Delay, d2	42.7		142.5	0.2	136.1	
Delay (s)	81.9		172.9	22.5	170.4	
Level of Service	F		F	C	F	
Approach Delay (s)	81.9			79.8	170.4	
Approach LOS	F			E	F	











Intersection Summary

HCM Average Control Delay	123.3	HCM Level of Service	F
HCM Volume to Capacity ratio	1.23		
Actuated Cycle Length (s)	124.6	Sum of lost time (s)	12.4
Intersection Capacity Utilization	107.2%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group











HCM Unsignalized Intersection Capacity Analysis
 7: Middle Street & Marrett Rd (Rte 2A)

2009 Existing PM

						
Movement	NBL	NBR	SET	SER	NWL	NWT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	41	16	716	48	0	472
Peak Hour Factor	0.54	0.54	0.76	0.76	0.83	0.83
Hourly flow rate (vph)	76	30	942	63	0	569
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1542	974			1005	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1542	974			1005	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	40	90			100	
cM capacity (veh/h)	127	308			697	
Direction, Lane #	NB 1	NB 2	SE 1	NW 1		
Volume Total	76	30	1005	569		
Volume Left	76	0	0	0		
Volume Right	0	30	63	0		
cSH	127	308	1700	1700		
Volume to Capacity	0.60	0.10	0.59	0.33		
Queue Length 95th (ft)	76	8	0	0		
Control Delay (s)	69.0	17.9	0.0	0.0		
Lane LOS	F	C				
Approach Delay (s)	54.7		0.0	0.0		
Approach LOS	F					
Intersection Summary						
Average Delay			3.4			
Intersection Capacity Utilization			50.6%		ICU Level of Service	A
Analysis Period (min)			15			











HCM Unsignalized Intersection Capacity Analysis
 7: Middle Street & Marrett Rd (Rte 2A)

2014 No Build PM

						
Movement	NBL	NBR	SET	SER	NWL	NWT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	41	18	764	49	0	472
Peak Hour Factor	0.54	0.54	0.76	0.76	0.83	0.83
Hourly flow rate (vph)	76	33	1005	64	0	569
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1606	1038			1070	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1606	1038			1070	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	34	88			100	
cM capacity (veh/h)	116	283			659	
Direction, Lane #	NB 1	NB 2	SE 1	NW 1		
Volume Total	76	33	1070	569		
Volume Left	76	0	0	0		
Volume Right	0	33	64	0		
cSH	116	283	1700	1700		
Volume to Capacity	0.66	0.12	0.63	0.33		
Queue Length 95th (ft)	85	10	0	0		
Control Delay (s)	82.0	19.4	0.0	0.0		
Lane LOS	F	C				
Approach Delay (s)	62.9		0.0	0.0		
Approach LOS	F					
Intersection Summary						
Average Delay			3.9			
Intersection Capacity Utilization			53.2%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
7: Middle Street & Marrett Rd (Rte 2A)

2014 Build PM

						
Movement	NBL	NBR	SET	SER	NWL	NWT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	41	18	774	49	0	502
Peak Hour Factor	0.54	0.54	0.76	0.76	0.83	0.83
Hourly flow rate (vph)	76	33	1018	64	0	605
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1655	1051			1083	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1655	1051			1083	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	30	88			100	
cM capacity (veh/h)	108	278			652	
Direction, Lane #	NB 1	NB 2	SE 1	NW 1		
Volume Total	76	33	1083	605		
Volume Left	76	0	0	0		
Volume Right	0	33	64	0		
cSH	108	278	1700	1700		
Volume to Capacity	0.70	0.12	0.64	0.36		
Queue Length 95th (ft)	93	10	0	0		
Control Delay (s)	94.3	19.7	0.0	0.0		
Lane LOS	F	C				
Approach Delay (s)	71.5		0.0	0.0		
Approach LOS	F					
Intersection Summary						
Average Delay			4.4			
Intersection Capacity Utilization			53.7%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 8: Hayden Ave & Rte 2 WB On-Ramp

2009 Existing PM

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗		↖		
Sign Control	Free			Free	Stop	
Grade	-2%			2%	0%	
Volume (veh/h)	211	157	220	208	0	0
Peak Hour Factor	0.88	0.88	0.90	0.90	1.00	1.00
Hourly flow rate (vph)	240	178	244	231	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			418		960	240
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			418		960	240
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			79		100	100
cM capacity (veh/h)			1141		224	799
Direction, Lane #	EB 1	EB 2	WB 1			
Volume Total	240	178	476			
Volume Left	0	0	244			
Volume Right	0	178	0			
cSH	1700	1700	1141			
Volume to Capacity	0.14	0.10	0.21			
Queue Length 95th (ft)	0	0	20			
Control Delay (s)	0.0	0.0	5.7			
Lane LOS			A			
Approach Delay (s)	0.0		5.7			
Approach LOS						
Intersection Summary						
Average Delay			3.0			
Intersection Capacity Utilization			40.9%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 8: Hayden Ave & Rte 2 WB On-Ramp

2014 No Build PM

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↗		↖		
Sign Control	Free			Free	Stop	
Grade	-2%			2%	0%	
Volume (veh/h)	337	517	232	255	0	0
Peak Hour Factor	0.82	0.82	0.89	0.89	1.00	1.00
Hourly flow rate (vph)	411	630	261	287	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			1041		1219	411
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1041		1219	411
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			61		100	100
cM capacity (veh/h)			668		121	641
Direction, Lane #	EB 1	EB 2	WB 1			
Volume Total	411	630	547			
Volume Left	0	0	261			
Volume Right	0	630	0			
cSH	1700	1700	668			
Volume to Capacity	0.24	0.37	0.39			
Queue Length 95th (ft)	0	0	46			
Control Delay (s)	0.0	0.0	10.0			
Lane LOS			A			
Approach Delay (s)	0.0		10.0			
Approach LOS						
Intersection Summary						
Average Delay			3.4			
Intersection Capacity Utilization			64.9%		ICU Level of Service	C
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 8: Hayden Ave & Rte 2 WB On-Ramp

2014 Build PM

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↑		↑		
Sign Control	Free			Free	Stop	
Grade	-2%			2%	0%	
Volume (veh/h)	397	622	232	293	0	0
Peak Hour Factor	0.82	0.82	0.89	0.89	1.00	1.00
Hourly flow rate (vph)	484	759	261	329	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			1243		1335	484
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1243		1335	484
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			53		100	100
cM capacity (veh/h)			560		91	583
Direction, Lane #	EB 1	EB 2	WB 1			
Volume Total	484	759	590			
Volume Left	0	0	261			
Volume Right	0	759	0			
cSH	1700	1700	560			
Volume to Capacity	0.28	0.45	0.47			
Queue Length 95th (ft)	0	0	61			
Control Delay (s)	0.0	0.0	12.9			
Lane LOS			B			
Approach Delay (s)	0.0		12.9			
Approach LOS						
Intersection Summary						
Average Delay			4.2			
Intersection Capacity Utilization			73.4%		ICU Level of Service	D
Analysis Period (min)			15			

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑	↖	↗
Sign Control	Free			Free	Stop	
Grade	2%			0%	-2%	
Volume (veh/h)	321	0	0	193	98	247
Peak Hour Factor	0.87	0.87	0.81	0.81	0.93	0.93
Hourly flow rate (vph)	369	0	0	238	105	266
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			369		607	369
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			369		607	369
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		77	61
cM capacity (veh/h)			1190		460	677
Direction, Lane #	EB 1	WB 1	NB 1	NB 2		
Volume Total	369	238	105	266		
Volume Left	0	0	105	0		
Volume Right	0	0	0	266		
cSH	1700	1700	460	677		
Volume to Capacity	0.22	0.14	0.23	0.39		
Queue Length 95th (ft)	0	0	22	47		
Control Delay (s)	0.0	0.0	15.1	13.7		
Lane LOS			C	B		
Approach Delay (s)	0.0	0.0	14.1			
Approach LOS			B			
Intersection Summary						
Average Delay			5.4			
Intersection Capacity Utilization			38.9%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 9: Hayden Ave & Rte 2 WB Off-Ramp

2014 No Build PM

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑	↖	↗
Sign Control	Free			Free	Stop	
Grade	2%			0%	-2%	
Volume (veh/h)	453	0	0	212	130	260
Peak Hour Factor	0.87	0.87	0.81	0.81	0.93	0.93
Hourly flow rate (vph)	521	0	0	262	140	280
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			521		782	521
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			521		782	521
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		61	50
cM capacity (veh/h)			1046		363	556
Direction, Lane #	EB 1	WB 1	NB 1	NB 2		
Volume Total	521	262	140	280		
Volume Left	0	0	140	0		
Volume Right	0	0	0	280		
cSH	1700	1700	363	556		
Volume to Capacity	0.31	0.15	0.39	0.50		
Queue Length 95th (ft)	0	0	44	70		
Control Delay (s)	0.0	0.0	21.0	17.9		
Lane LOS			C	C		
Approach Delay (s)	0.0	0.0	18.9			
Approach LOS			C			
Intersection Summary						
Average Delay			6.6			
Intersection Capacity Utilization			46.6%		ICU Level of Service	A
Analysis Period (min)			15			













HCM Unsignalized Intersection Capacity Analysis
 9: Hayden Ave & Rte 2 WB Off-Ramp

2014 Build PM

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑	↖	↗
Sign Control	Free			Free	Stop	
Grade	2%			0%	-2%	
Volume (veh/h)	513	0	0	226	154	260
Peak Hour Factor	0.87	0.87	0.81	0.81	0.93	0.93
Hourly flow rate (vph)	590	0	0	279	166	280
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			590		869	590
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			590		869	590
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		49	45
cM capacity (veh/h)			986		323	508
Direction, Lane #	EB 1	WB 1	NB 1	NB 2		
Volume Total	590	279	166	280		
Volume Left	0	0	166	0		
Volume Right	0	0	0	280		
cSH	1700	1700	323	508		
Volume to Capacity	0.35	0.16	0.51	0.55		
Queue Length 95th (ft)	0	0	69	82		
Control Delay (s)	0.0	0.0	27.3	20.4		
Lane LOS			D	C		
Approach Delay (s)	0.0	0.0	23.0			
Approach LOS			C			
Intersection Summary						
Average Delay			7.8			
Intersection Capacity Utilization			49.8%	ICU Level of Service	A	
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis
 10: Hayden Ave & Waltham Street

2009 Existing PM

							
Movement	EBL	EBR	NBL	NBT	SBT	SBR	
Lane Configurations							
Sign Control	Stop			Free	Free		
Grade	0%			2%	-2%		
Volume (veh/h)	101	467	145	660	590	47	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.95	0.95	
Hourly flow rate (vph)	109	502	156	710	621	49	
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type	None						
Median storage (veh)							
Upstream signal (ft)							
pX, platoon unblocked							
vC, conflicting volume	1312	335	671				
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol	1312	335	671				
tC, single (s)	6.8	6.9	4.1				
tC, 2 stage (s)							
tF (s)	3.5	3.3	2.2				
p0 queue free %	13	24	83				
cM capacity (veh/h)	124	661	916				
Direction, Lane #	EB 1	EB 2	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	109	502	156	355	355	414	256
Volume Left	109	0	156	0	0	0	0
Volume Right	0	502	0	0	0	0	49
cSH	124	661	916	1700	1700	1700	1700
Volume to Capacity	0.87	0.76	0.17	0.21	0.21	0.24	0.15
Queue Length 95th (ft)	137	176	15	0	0	0	0
Control Delay (s)	115.7	25.6	9.7	0.0	0.0	0.0	0.0
Lane LOS	F	D	A				
Approach Delay (s)	41.6		1.8			0.0	
Approach LOS	E						
Intersection Summary							
Average Delay			12.5				
Intersection Capacity Utilization			53.4%		ICU Level of Service		A
Analysis Period (min)			15				

HCM Unsignalized Intersection Capacity Analysis
 10: Hayden Ave & Waltham Street

2014 No Build PM















Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			2%	-2%	
Volume (veh/h)	163	550	158	702	621	54
Peak Hour Factor	0.93	0.93	0.95	0.95	0.89	0.89
Hourly flow rate (vph)	175	591	166	739	698	61
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1430	379	758			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1430	379	758			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	0	4	80			
cM capacity (veh/h)	101	619	849			

Direction, Lane #	EB 1	EB 2	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	175	591	166	369	369	465	293
Volume Left	175	0	166	0	0	0	0
Volume Right	0	591	0	0	0	0	61
cSH	101	619	849	1700	1700	1700	1700
Volume to Capacity	1.74	0.96	0.20	0.22	0.22	0.27	0.17
Queue Length 95th (ft)	350	332	18	0	0	0	0
Control Delay (s)	442.2	51.9	10.3	0.0	0.0	0.0	0.0
Lane LOS	F	F	B				
Approach Delay (s)	141.1		1.9			0.0	
Approach LOS	F						

Intersection Summary			
Average Delay		45.2	
Intersection Capacity Utilization	59.6%		ICU Level of Service B
Analysis Period (min)		15	

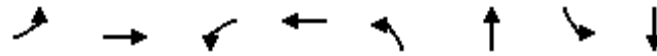
HCM Unsignalized Intersection Capacity Analysis
 10: Hayden Ave & Waltham Street

2014 Build PM

							
Movement	EBL	EBR	NBL	NBT	SBT	SBR	
Lane Configurations							
Sign Control	Stop			Free	Free		
Grade	0%			2%	-2%		
Volume (veh/h)	208	565	162	702	621	64	
Peak Hour Factor	0.93	0.93	0.95	0.95	0.89	0.89	
Hourly flow rate (vph)	224	608	171	739	698	72	
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type	None						
Median storage (veh)							
Upstream signal (ft)							
pX, platoon unblocked							
vC, conflicting volume	1444	385	770				
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol	1444	385	770				
tC, single (s)	6.8	6.9	4.1				
tC, 2 stage (s)							
tF (s)	3.5	3.3	2.2				
p0 queue free %	0	1	80				
cM capacity (veh/h)	98	613	841				
Direction, Lane #	EB 1	EB 2	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	224	608	171	369	369	465	304
Volume Left	224	0	171	0	0	0	0
Volume Right	0	608	0	0	0	0	72
cSH	98	613	841	1700	1700	1700	1700
Volume to Capacity	2.28	0.99	0.20	0.22	0.22	0.27	0.18
Queue Length 95th (ft)	498	368	19	0	0	0	0
Control Delay (s)	679.3	59.9	10.4	0.0	0.0	0.0	0.0
Lane LOS	F	F	B				
Approach Delay (s)	226.6		1.9	0.0			
Approach LOS	F						
Intersection Summary							
Average Delay			75.7				
Intersection Capacity Utilization			60.9%	ICU Level of Service	B		
Analysis Period (min)			15				

Timings
11: Marrett Rd (Rte 2A) & Waltham Street

2009 Existing PM

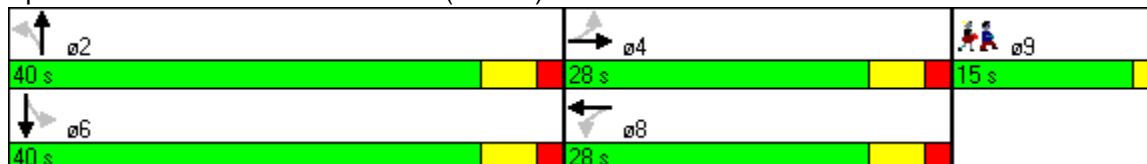


Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	ø9
Lane Configurations		↕		↕	↗	↖	↗	↖	↖
Volume (vph)	157	399	67	199	98	714	51	623	
Lane Group Flow (vph)	0	718	0	381	101	827	58	798	
Turn Type	Perm		Perm		Perm		Perm		
Protected Phases		4		8		2		6	9
Permitted Phases	4		8		2		6		
Detector Phases	4	4	8	8	2	2	6	6	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2.0
Minimum Split (s)	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	15.0
Total Split (s)	28.0	28.0	28.0	28.0	40.0	40.0	40.0	40.0	15.0
Total Split (%)	33.7%	33.7%	33.7%	33.7%	48.2%	48.2%	48.2%	48.2%	18%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.0
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	Max	Max	Max	Max	Max	Max	Max	Max	Max
v/c Ratio		1.95		1.14	1.10	1.03	0.64	0.99	
Control Delay		458.2		122.4	153.1	65.2	55.8	53.8	
Queue Delay		0.0		0.0	0.0	0.0	0.0	0.0	
Total Delay		458.2		122.4	153.1	65.2	55.8	53.8	
Queue Length 50th (ft)		~586		~235	~61	~467	23	398	
Queue Length 95th (ft)		#793		#355	#157	#685	#87	#623	
Internal Link Dist (ft)		2445		873		4387		1908	
Turn Bay Length (ft)					200		200		
Base Capacity (vph)		369		335	92	803	90	809	
Starvation Cap Reductn		0		0	0	0	0	0	
Spillback Cap Reductn		0		0	0	0	0	0	
Storage Cap Reductn		0		0	0	0	0	0	
Reduced v/c Ratio		1.95		1.14	1.10	1.03	0.64	0.99	

Intersection Summary



















Cycle Length: 83
 Actuated Cycle Length: 83
 Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
 Natural Cycle: 140
 Control Type: Pretimed
 ~ Volume exceeds capacity, queue is theoretically infinite.
 Queue shown is maximum after two cycles.
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 11: Marrett Rd (Rte 2A) & Waltham Street



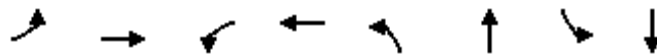
HCM Signalized Intersection Capacity Analysis
 11: Marrett Rd (Rte 2A) & Waltham Street

2009 Existing PM

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Frt		0.97			0.98		1.00	0.98		1.00	0.98	
Flt Protected		0.99			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1820			1806		1805	1852		1770	1866	
Flt Permitted		0.69			0.63		0.11	1.00		0.11	1.00	
Satd. Flow (perm)		1276			1157		211	1852		207	1866	
Volume (vph)	157	399	141	67	199	50	98	714	88	51	623	79
Peak-hour factor, PHF	0.97	0.97	0.97	0.83	0.83	0.83	0.97	0.97	0.97	0.88	0.88	0.88
Adj. Flow (vph)	162	411	145	81	240	60	101	736	91	58	708	90
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	718	0	0	381	0	101	827	0	58	798	0
Heavy Vehicles (%)	1%	0%	1%	0%	2%	4%	0%	1%	0%	2%	0%	1%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		22.0			22.0		34.0	34.0		34.0	34.0	
Effective Green, g (s)		24.0			24.0		36.0	36.0		36.0	36.0	
Actuated g/C Ratio		0.29			0.29		0.43	0.43		0.43	0.43	
Clearance Time (s)		6.0			6.0		6.0	6.0		6.0	6.0	
Lane Grp Cap (vph)		369			335		92	803		90	809	
v/s Ratio Prot								0.45			0.43	
v/s Ratio Perm		c0.56			0.33		c0.48			0.28		
v/c Ratio		1.95			1.14		1.10	1.03		0.64	0.99	
Uniform Delay, d1		29.5			29.5		23.5	23.5		18.5	23.3	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		435.4			91.8		122.8	39.7		30.5	28.5	
Delay (s)		464.9			121.3		146.3	63.2		48.9	51.8	
Level of Service		F			F		F	E		D	D	
Approach Delay (s)		464.9			121.3			72.2			51.6	
Approach LOS		F			F			E			D	
Intersection Summary												
HCM Average Control Delay		170.4					HCM Level of Service			F		
HCM Volume to Capacity ratio		1.44										
Actuated Cycle Length (s)		83.0					Sum of lost time (s)		23.0			
Intersection Capacity Utilization		108.6%					ICU Level of Service		G			
Analysis Period (min)		15										
c Critical Lane Group												

Timings
11: Marrett Rd (Rte 2A) & Waltham Street

2014 No Build PM



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	ø9
Lane Configurations	↶	↷	↶	↷	↶	↷		↶↷	
Volume (vph)	197	439	86	214	98	732	51	642	
Lane Group Flow (vph)	207	610	91	278	103	902	0	834	
Turn Type	Perm		pm+pt		pm+pt		Perm		
Protected Phases		4	3	8	5	2		6	9
Permitted Phases	4		8		2		6		
Detector Phases	4	4	3	8	5	2	6	6	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2.0
Minimum Split (s)	22.0	22.0	8.0	22.0	8.0	22.0	22.0	22.0	15.0
Total Split (s)	49.0	49.0	8.0	57.0	8.0	78.0	70.0	70.0	15.0
Total Split (%)	32.7%	32.7%	5.3%	38.0%	5.3%	52.0%	46.7%	46.7%	10%
Yellow Time (s)	4.0	4.0	3.0	4.0	3.0	4.0	4.0	4.0	2.0
All-Red Time (s)	2.0	2.0	1.0	2.0	1.0	2.0	2.0	2.0	0.0
Lead/Lag	Lag	Lag	Lead		Lead		Lag	Lag	
Lead-Lag Optimize?									
Recall Mode	None	None	None	None	None	Max	Max	Max	None
v/c Ratio	0.66	1.02	0.84	0.40	0.41	0.91		0.98dl	
Control Delay	52.3	88.1	85.9	33.9	22.6	43.9		51.4	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0		0.0	
Total Delay	52.3	88.1	85.9	33.9	22.6	43.9		51.4	
Queue Length 50th (ft)	154	~536	51	174	42	676		346	
Queue Length 95th (ft)	#288	#921	#160	295	89	#1168		#584	
Internal Link Dist (ft)		2445		873		4387		1908	
Turn Bay Length (ft)	200		200		200				
Base Capacity (vph)	316	597	108	693	252	990		899	
Starvation Cap Reductn	0	0	0	0	0	0		0	
Spillback Cap Reductn	0	0	0	0	0	0		0	
Storage Cap Reductn	0	0	0	0	0	0		0	
Reduced v/c Ratio	0.66	1.02	0.84	0.40	0.41	0.91		0.93	

Intersection Summary

Cycle Length: 150

Actuated Cycle Length: 138

Natural Cycle: 150

Control Type: Actuated-Uncoordinated

~ Volume exceeds capacity, queue is theoretically infinite.

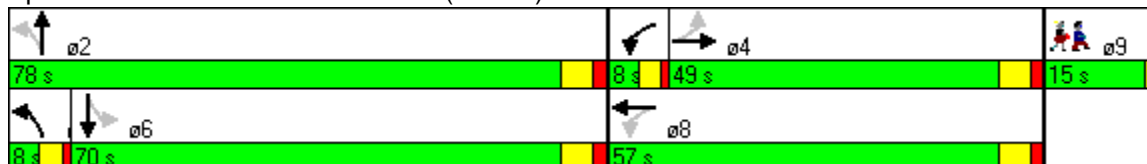
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

Splits and Phases: 11: Marrett Rd (Rte 2A) & Waltham Street



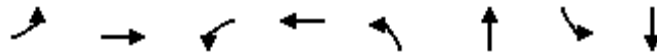
HCM Signalized Intersection Capacity Analysis
 11: Marrett Rd (Rte 2A) & Waltham Street

2014 No Build PM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			0.95	
Frt	1.00	0.96		1.00	0.97		1.00	0.98			0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)	1787	1826		1805	1803		1805	1843			3522	
Flt Permitted	0.54	1.00		0.08	1.00		0.22	1.00			0.59	
Satd. Flow (perm)	1014	1826		155	1803		425	1843			2075	
Volume (vph)	197	439	141	86	214	50	98	732	124	51	642	99
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	207	462	148	91	225	53	103	771	131	54	676	104
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	207	610	0	91	278	0	103	902	0	0	834	0
Heavy Vehicles (%)	1%	0%	1%	0%	2%	4%	0%	1%	0%	2%	0%	1%
Turn Type	Perm			pm+pt			pm+pt				Perm	
Protected Phases		4		3	8		5	2				6
Permitted Phases	4			8			2				6	
Actuated Green, G (s)	43.1	43.1		51.1	51.1		72.1	72.1			64.1	
Effective Green, g (s)	45.1	45.1		53.1	53.1		74.1	74.1			66.1	
Actuated g/C Ratio	0.32	0.32		0.38	0.38		0.53	0.53			0.47	
Clearance Time (s)	6.0	6.0		4.0	6.0		4.0	6.0			6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	328	590		106	686		265	978			983	
v/s Ratio Prot		c0.33		c0.02	0.15		0.01	c0.49				
v/s Ratio Perm	0.20			0.30			0.20				0.40	
v/c Ratio	0.63	1.03		0.86	0.41		0.39	0.92			0.98dl	
Uniform Delay, d1	40.2	47.2		40.6	31.7		18.7	30.1			32.3	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	3.9	46.1		45.6	0.4		0.9	15.2			9.0	
Delay (s)	44.1	93.3		86.2	32.1		19.6	45.3			41.4	
Level of Service	D	F		F	C		B	D			D	
Approach Delay (s)		80.8			45.4			42.7			41.4	
Approach LOS		F			D			D			D	
Intersection Summary												
HCM Average Control Delay			53.0			HCM Level of Service					D	
HCM Volume to Capacity ratio			0.96									
Actuated Cycle Length (s)			139.6			Sum of lost time (s)			16.4			
Intersection Capacity Utilization			118.2%			ICU Level of Service					H	
Analysis Period (min)			15									
dl Defacto Left Lane. Recode with 1 though lane as a left lane.												
c Critical Lane Group												

Timings
11: Marrett Rd (Rte 2A) & Waltham Street

2014 Build PM



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT	ø9
Lane Configurations	↶	↷	↶	↷	↶	↷		↶↷	
Volume (vph)	205	446	91	219	98	754	51	647	
Lane Group Flow (vph)	216	617	96	284	103	949	0	844	
Turn Type	Perm		pm+pt		pm+pt		Perm		
Protected Phases		4	3	8	5	2		6	9
Permitted Phases	4		8		2		6		
Detector Phases	4	4	3	8	5	2	6	6	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2.0
Minimum Split (s)	22.0	22.0	8.0	22.0	8.0	22.0	22.0	22.0	15.0
Total Split (s)	49.0	49.0	8.0	57.0	8.0	78.0	70.0	70.0	15.0
Total Split (%)	32.7%	32.7%	5.3%	38.0%	5.3%	52.0%	46.7%	46.7%	10%
Yellow Time (s)	4.0	4.0	3.0	4.0	3.0	4.0	4.0	4.0	2.0
All-Red Time (s)	2.0	2.0	1.0	2.0	1.0	2.0	2.0	2.0	0.0
Lead/Lag	Lag	Lag	Lead		Lead		Lag	Lag	
Lead-Lag Optimize?									
Recall Mode	None	None	None	None	None	Max	Max	Max	None
v/c Ratio	0.69	1.03	0.89	0.41	0.41	0.96		0.98dl	
Control Delay	54.7	91.0	95.4	34.0	22.8	51.8		55.3	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0		0.0	
Total Delay	54.7	91.0	95.4	34.0	22.8	51.8		55.3	
Queue Length 50th (ft)	163	~554	54	178	42	750		356	
Queue Length 95th (ft)	#322	#935	#173	302	89	#1265		#600	
Internal Link Dist (ft)		2445		873		4387		1908	
Turn Bay Length (ft)	200		200		200				
Base Capacity (vph)	311	597	108	694	249	988		888	
Starvation Cap Reductn	0	0	0	0	0	0		0	
Spillback Cap Reductn	0	0	0	0	0	0		0	
Storage Cap Reductn	0	0	0	0	0	0		0	
Reduced v/c Ratio	0.69	1.03	0.89	0.41	0.41	0.96		0.95	

Intersection Summary

Cycle Length: 150

Actuated Cycle Length: 138

Natural Cycle: 150

Control Type: Actuated-Uncoordinated

~ Volume exceeds capacity, queue is theoretically infinite.

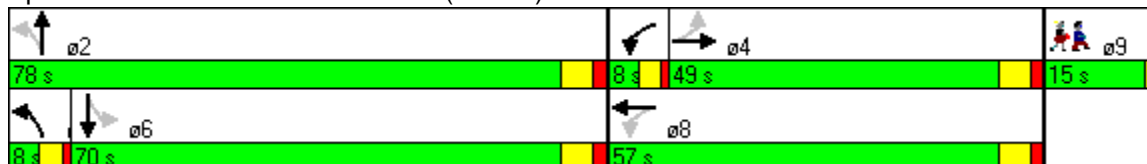
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

Splits and Phases: 11: Marrett Rd (Rte 2A) & Waltham Street


















HCM Signalized Intersection Capacity Analysis
 11: Marrett Rd (Rte 2A) & Waltham Street

2014 Build PM

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			0.95	
Frt	1.00	0.96		1.00	0.97		1.00	0.98			0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)	1787	1827		1805	1804		1805	1838			3520	
Flt Permitted	0.53	1.00		0.08	1.00		0.22	1.00			0.55	
Satd. Flow (perm)	999	1827		155	1804		417	1838			1956	
Volume (vph)	205	446	141	91	219	50	98	754	147	51	647	104
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	216	469	148	96	231	53	103	794	155	54	681	109
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	216	617	0	96	284	0	103	949	0	0	844	0
Heavy Vehicles (%)	1%	0%	1%	0%	2%	4%	0%	1%	0%	2%	0%	1%
Turn Type	Perm			pm+pt			pm+pt				Perm	
Protected Phases		4		3	8		5	2				6
Permitted Phases	4			8			2				6	
Actuated Green, G (s)	43.1	43.1		51.1	51.1		72.1	72.1			64.1	
Effective Green, g (s)	45.1	45.1		53.1	53.1		74.1	74.1			66.1	
Actuated g/C Ratio	0.32	0.32		0.38	0.38		0.53	0.53			0.47	
Clearance Time (s)	6.0	6.0		4.0	6.0		4.0	6.0			6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	323	590		106	686		261	976			926	
v/s Ratio Prot		c0.34		c0.03	0.16		0.01	c0.52				
v/s Ratio Perm	0.22			0.32			0.20				0.43	
v/c Ratio	0.67	1.05		0.91	0.41		0.39	0.97			0.98dl	
Uniform Delay, d1	40.8	47.2		69.6	31.8		18.8	31.8			34.0	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	5.2	49.6		57.9	0.4		1.0	22.9			14.6	
Delay (s)	46.0	96.8		127.5	32.2		19.8	54.6			48.7	
Level of Service	D	F		F	C		B	D			D	
Approach Delay (s)		83.6			56.3			51.2			48.7	
Approach LOS		F			E			D			D	
Intersection Summary												
HCM Average Control Delay			59.8			HCM Level of Service					E	
HCM Volume to Capacity ratio			1.00									
Actuated Cycle Length (s)			139.6			Sum of lost time (s)			16.4			
Intersection Capacity Utilization			121.7%			ICU Level of Service					H	
Analysis Period (min)			15									
dl Defacto Left Lane. Recode with 1 though lane as a left lane.												
c Critical Lane Group												

Timings
12: Waltham Street & Worthen Road

2009 Existing PM

									
Lane Group	NBL	NBT	SBL	SBT	SEL	SET	NWL	NWT	ø9
Lane Configurations									
Volume (vph)	337	552	24	343	65	128	10	52	
Lane Group Flow (vph)	370	621	26	439	0	681	0	92	
Turn Type	pm+pt		pm+pt		Perm		Perm		
Protected Phases	5	2	1	6		4		8	9
Permitted Phases	2		6		4		8		
Detector Phases	5	2	1	6	4	4	8	8	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2.0
Minimum Split (s)	8.0	15.0	8.0	15.0	15.0	15.0	15.0	15.0	20.0
Total Split (s)	10.0	35.0	10.0	35.0	25.0	25.0	25.0	25.0	20.0
Total Split (%)	11.1%	38.9%	11.1%	38.9%	27.8%	27.8%	27.8%	27.8%	22%
Yellow Time (s)	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	0.0
Lead/Lag	Lead	Lag	Lead	Lag					
Lead-Lag Optimize?									
Recall Mode	None	Max	None	Max	None	None	None	None	None
v/c Ratio	0.96	0.63	0.11	0.53		0.92dr		0.11	
Control Delay	53.0	17.0	8.0	17.2		30.4		18.3	
Queue Delay	0.0	0.0	0.0	0.0		0.0		0.0	
Total Delay	53.0	17.0	8.0	17.2		30.4		18.3	
Queue Length 50th (ft)	75	149	4	132		140		14	
Queue Length 95th (ft)	#217	#341	13	211		180		30	
Internal Link Dist (ft)		1908		1020		2764		1357	
Turn Bay Length (ft)	100		100						
Base Capacity (vph)	385	982	243	824		868		828	
Starvation Cap Reductn	0	0	0	0		0		0	
Spillback Cap Reductn	0	0	0	0		0		0	
Storage Cap Reductn	0	0	0	0		0		0	
Reduced v/c Ratio	0.96	0.63	0.11	0.53		0.78		0.11	

Intersection Summary

Cycle Length: 90

Actuated Cycle Length: 70

Natural Cycle: 90

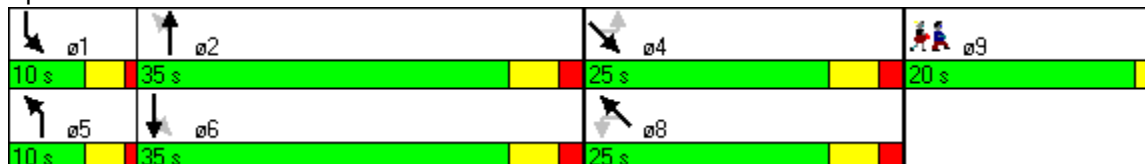
Control Type: Actuated-Uncoordinated

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.





















dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Splits and Phases: 12: Waltham Street & Worthen Road



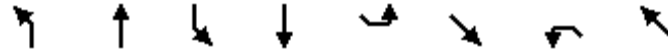
HCM Signalized Intersection Capacity Analysis
 12: Waltham Street & Worthen Road

2009 Existing PM

												
Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			0.95			0.95	
Frt	1.00	1.00		1.00	0.98			0.90			0.96	
Flt Protected	0.95	1.00		0.95	1.00			0.99			0.99	
Satd. Flow (prot)	1770	1857		1805	1860			3199			3416	
Flt Permitted	0.34	1.00		0.29	1.00			0.90			0.87	
Satd. Flow (perm)	635	1857		546	1860			2904			2994	
Volume (vph)	337	552	13	24	343	56	65	128	373	10	52	19
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.83	0.83	0.83	0.88	0.88	0.88
Adj. Flow (vph)	370	607	14	26	377	62	78	154	449	11	59	22
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	370	621	0	26	439	0	0	681	0	0	92	0
Heavy Vehicles (%)	2%	2%	0%	0%	0%	0%	2%	1%	1%	0%	2%	0%
Turn Type	pm+pt		pm+pt		Perm			Perm				
Protected Phases	5	2		1	6			4			8	
Permitted Phases	2			6			4			8		
Actuated Green, G (s)	41.0	35.0		33.8	31.4			19.0			19.0	
Effective Green, g (s)	43.0	37.0		35.8	33.4			21.0			21.0	
Actuated g/C Ratio	0.59	0.51		0.49	0.46			0.29			0.29	
Clearance Time (s)	4.0	6.0		4.0	6.0			6.0			6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	471	949		312	858			842			868	
v/s Ratio Prot	c0.07	0.33		0.00	0.24							
v/s Ratio Perm	c0.40			0.04				c0.23			0.03	
v/c Ratio	0.79	0.65		0.08	0.51			0.92dr			0.11	
Uniform Delay, d1	11.2	13.0		10.3	13.7			23.8			18.8	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	8.4	3.5		0.1	2.2			5.8			0.1	
Delay (s)	19.6	16.5		10.4	15.9			29.6			18.9	
Level of Service	B	B		B	B			C			B	
Approach Delay (s)		17.7			15.6			29.6			18.9	
Approach LOS		B			B			C			B	
Intersection Summary												
HCM Average Control Delay			20.9	HCM Level of Service		C						
HCM Volume to Capacity ratio			0.83									
Actuated Cycle Length (s)			72.4	Sum of lost time (s)		12.0						
Intersection Capacity Utilization			70.9%	ICU Level of Service		C						
Analysis Period (min)			15									
dr Defacto Right Lane. Recode with 1 though lane as a right lane.												
c Critical Lane Group												

Timings
12: Waltham Street & Worthen Road

2014 No Build PM



Lane Group	NBL	NBT	SBL	SBT	SEL	SET	NWL	NWT	ø9
Lane Configurations	↙	↗	↙	↗		↕		↕	
Volume (vph)	337	610	24	382	65	128	10	52	
Lane Group Flow (vph)	355	656	25	461	0	596	0	86	
Turn Type	pm+pt		pm+pt		Perm		Perm		
Protected Phases	5	2	1	6		4		8	9
Permitted Phases	2		6		4		8		
Detector Phases	5	2	1	6	4	4	8	8	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2.0
Minimum Split (s)	8.0	15.0	8.0	15.0	15.0	15.0	15.0	15.0	20.0
Total Split (s)	18.0	39.0	8.0	29.0	23.0	23.0	23.0	23.0	20.0
Total Split (%)	20.0%	43.3%	8.9%	32.2%	25.6%	25.6%	25.6%	25.6%	22%
Yellow Time (s)	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	0.0
Lead/Lag	Lead	Lag	Lead	Lag					
Lead-Lag Optimize?									
Recall Mode	None	Max	None	Max	None	None	None	None	None
v/c Ratio	0.77	0.62	0.13	0.69		0.89dr		0.11	
Control Delay	26.5	14.4	8.9	25.8		30.8		19.8	
Queue Delay	0.0	0.0	0.0	0.0		0.0		0.0	
Total Delay	26.5	14.4	8.9	25.8		30.8		19.8	
Queue Length 50th (ft)	89	148	4	166		123		14	
Queue Length 95th (ft)	#215	324	12	266		#183		31	
Internal Link Dist (ft)		1908		1020		2764		1357	
Turn Bay Length (ft)	100		100						
Base Capacity (vph)	460	1056	199	666		788		756	
Starvation Cap Reductn	0	0	0	0		0		0	
Spillback Cap Reductn	0	0	0	0		0		0	
Storage Cap Reductn	0	0	0	0		0		0	
Reduced v/c Ratio	0.77	0.62	0.13	0.69		0.76		0.11	

Intersection Summary

Cycle Length: 90

Actuated Cycle Length: 70

Natural Cycle: 90

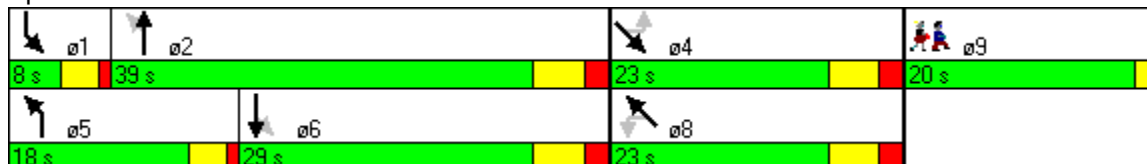
Control Type: Actuated-Uncoordinated

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.





















dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Splits and Phases: 12: Waltham Street & Worthen Road



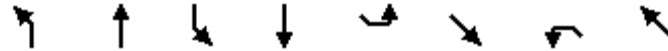
HCM Signalized Intersection Capacity Analysis
12: Waltham Street & Worthen Road

2014 No Build PM

												
Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			0.95			0.95	
Frt	1.00	1.00		1.00	0.98			0.90			0.97	
Flt Protected	0.95	1.00		0.95	1.00			0.99			0.99	
Satd. Flow (prot)	1770	1858		1805	1864			3199			3418	
Flt Permitted	0.25	1.00		0.38	1.00			0.90			0.87	
Satd. Flow (perm)	470	1858		724	1864			2911			2999	
Volume (vph)	337	610	13	24	382	56	65	128	373	10	52	19
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	355	642	14	25	402	59	68	135	393	11	55	20
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	355	656	0	25	461	0	0	596	0	0	86	0
Heavy Vehicles (%)	2%	2%	0%	0%	0%	0%	2%	1%	1%	0%	2%	0%
Turn Type	pm+pt		pm+pt		Perm			Perm				
Protected Phases	5	2		1	6			4			8	
Permitted Phases	2			6			4			8		
Actuated Green, G (s)	43.4	37.8		27.0	25.4			17.0			17.0	
Effective Green, g (s)	45.4	39.8		29.0	27.4			19.0			19.0	
Actuated g/C Ratio	0.63	0.55		0.40	0.38			0.26			0.26	
Clearance Time (s)	4.0	6.0		4.0	6.0			6.0			6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	546	1021		314	705			764			787	
v/s Ratio Prot	c0.13	0.35		0.00	0.25							
v/s Ratio Perm	c0.28			0.03				c0.20			0.03	
v/c Ratio	0.65	0.64		0.08	0.65			0.89dr			0.11	
Uniform Delay, d1	9.0	11.3		13.2	18.6			24.8			20.3	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	2.8	3.1		0.1	4.7			5.2			0.1	
Delay (s)	11.8	14.5		13.3	23.3			29.9			20.3	
Level of Service	B	B		B	C			C			C	
Approach Delay (s)		13.5			22.8			29.9			20.3	
Approach LOS		B			C			C			C	
Intersection Summary												
HCM Average Control Delay			20.3	HCM Level of Service				C				
HCM Volume to Capacity ratio			0.68									
Actuated Cycle Length (s)			72.4	Sum of lost time (s)				8.0				
Intersection Capacity Utilization			73.0%	ICU Level of Service				C				
Analysis Period (min)			15									
dr Defacto Right Lane. Recode with 1 though lane as a right lane.												
c Critical Lane Group												

Timings
12: Waltham Street & Worthen Road

2014 Build PM



Lane Group	NBL	NBT	SBL	SBT	SEL	SET	NWL	NWT	ø9
Lane Configurations	↙	↘	↙	↘		↕		↕	
Volume (vph)	337	640	24	392	65	128	10	52	
Lane Group Flow (vph)	370	717	26	493	0	681	0	92	
Turn Type	pm+pt		pm+pt		Perm		Perm		
Protected Phases	5	2	1	6		4		8	9
Permitted Phases	2		6		4		8		
Detector Phases	5	2	1	6	4	4	8	8	
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2.0
Minimum Split (s)	8.0	15.0	8.0	15.0	15.0	15.0	15.0	15.0	20.0
Total Split (s)	18.0	39.0	8.0	29.0	23.0	23.0	23.0	23.0	20.0
Total Split (%)	20.0%	43.3%	8.9%	32.2%	25.6%	25.6%	25.6%	25.6%	22%
Yellow Time (s)	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	0.0
Lead/Lag	Lead	Lag	Lead	Lag					
Lead-Lag Optimize?									
Recall Mode	None	Max	None	Max	None	None	None	None	None
v/c Ratio	0.80	0.68	0.13	0.74		1.02dr		0.13	
Control Delay	29.3	16.1	9.0	28.0		38.3		19.9	
Queue Delay	0.0	0.0	0.0	0.0		0.0		0.0	
Total Delay	29.3	16.1	9.0	28.0		38.3		19.9	
Queue Length 50th (ft)	97	171	4	182		146		15	
Queue Length 95th (ft)	#232	#377	12	#300		#207		31	
Internal Link Dist (ft)		1908		1020		2764		1357	
Turn Bay Length (ft)	100		100						
Base Capacity (vph)	460	1056	199	666		784		707	
Starvation Cap Reductn	0	0	0	0		0		0	
Spillback Cap Reductn	0	0	0	0		0		0	
Storage Cap Reductn	0	0	0	0		0		0	
Reduced v/c Ratio	0.80	0.68	0.13	0.74		0.87		0.13	

Intersection Summary

Cycle Length: 90

Actuated Cycle Length: 70

Natural Cycle: 90

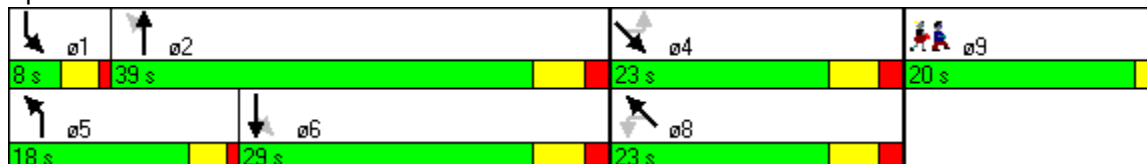
Control Type: Actuated-Uncoordinated

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.





















dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Splits and Phases: 12: Waltham Street & Worthen Road



HCM Signalized Intersection Capacity Analysis
12: Waltham Street & Worthen Road

2014 Build PM

												
Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			0.95			0.95	
Frt	1.00	1.00		1.00	0.98			0.90			0.96	
Flt Protected	0.95	1.00		0.95	1.00			0.99			0.99	
Satd. Flow (prot)	1770	1858		1805	1864			3199			3416	
Flt Permitted	0.22	1.00		0.32	1.00			0.90			0.85	
Satd. Flow (perm)	414	1858		605	1864			2901			2937	
Volume (vph)	337	640	13	24	392	56	65	128	373	10	52	19
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.83	0.83	0.83	0.88	0.88	0.88
Adj. Flow (vph)	370	703	14	26	431	62	78	154	449	11	59	22
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	370	717	0	26	493	0	0	681	0	0	92	0
Heavy Vehicles (%)	2%	2%	0%	0%	0%	0%	2%	1%	1%	0%	2%	0%
Turn Type	pm+pt			pm+pt			Perm			Perm		
Protected Phases	5	2		1	6			4			8	
Permitted Phases	2			6			4			8		
Actuated Green, G (s)	43.4	37.8		27.0	25.4			17.0			17.0	
Effective Green, g (s)	45.4	39.8		29.0	27.4			19.0			19.0	
Actuated g/C Ratio	0.63	0.55		0.40	0.38			0.26			0.26	
Clearance Time (s)	4.0	6.0		4.0	6.0			6.0			6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	522	1021		269	705			761			771	
v/s Ratio Prot	c0.14	0.39		0.00	0.26							
v/s Ratio Perm	c0.31			0.04				c0.23			0.03	
v/c Ratio	0.71	0.70		0.10	0.70			1.02dr			0.12	
Uniform Delay, d1	9.7	12.0		13.4	19.0			25.7			20.3	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	4.4	4.0		0.2	5.7			13.0			0.1	
Delay (s)	14.1	16.0		13.5	24.7			38.7			20.4	
Level of Service	B	B		B	C			D			C	
Approach Delay (s)		15.4			24.2			38.7			20.4	
Approach LOS		B			C			D			C	
Intersection Summary												
HCM Average Control Delay			24.2			HCM Level of Service					C	
HCM Volume to Capacity ratio			0.75									
Actuated Cycle Length (s)			72.4			Sum of lost time (s)			8.0			
Intersection Capacity Utilization			73.5%			ICU Level of Service					D	
Analysis Period (min)			15									
dr Defacto Right Lane. Recode with 1 though lane as a right lane.												
c Critical Lane Group												